LEARNING FROM THE LOCAL SCALE: IDENTIFYING AND ADDRESSING LOCAL BLIND SPOTS IN ARCTIC ENVIRONMENTAL GOVERNANCE

By

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Abstract

Environmental governance in the context of climate change adaptation brings together diverse actors and stakeholders to develop and enact policies across a broad range of scales. However, local needs and priorities are often mismatched with those pursued by entities at different levels of decision-making. This mismatch is perpetuated, in part, by the dominating influence of the Western worldview in knowledge processes involving the creation, sharing, and use of environmental knowledge. Persistent biases that favor Western science and technical information while marginalizing other important sources like local and Indigenous knowledge create blind spots that may adversely affect adaptation outcomes. In this research, a case study of the Native Village of Wainwright, Alaska is used to explore the topic of information blind spots in environmental governance resulting from 1) low resolution tools employed within broad scale adaptation initiatives; 2) preferences for easily quantifiable information; and 3) the challenge of communicating context-rich details to outside decision makers, given disciplinary biases and organizational conventions. This dissertation comprises manuscripts based on three studies undertaken to address the above blind spots in specific areas of adaptation planning. The first manuscript furthers conventional methods of adaptation classification through a place-based approach that uses directed content analysis to identify aspects of local adaptation not readily captured by low resolution frameworks. The second manuscript employs contextual analysis and extends Ostrom's Institutional Analysis and Development framework to characterize the role of local informal institutions in adaptation and provide insights into how difficult-to-quantify social and cultural norms might be leveraged in planned adaptation initiatives. The third manuscript reports on a formative endeavor that looked practically at conventions for communicating environmental change to public sector decision-makers, and tested a survey that explored the potential for context-rich visuals and other reporting strategies to effectively convey information about local observations and experiences of change.

The research reported in the first manuscript found appreciable differences between aspects of adaptation captured in place-based and low resolution classification approaches related to the unique local context of Wainwright, including the subsistence-cash economy that exists there. The second manuscript reports how patterns of past adaptation point to several informal institutions that have historically been associated with local adaptation responses and elements of adaptive capacity. Based on these findings, arguments are made for expanded planning discourse that goes beyond outside interventions to include the already existing strategies used by households and social groups, as well as targeted support of informal institutions that strengthen the inherent ability to adapt of local communities. The third manuscript reports promising results from the formative study, which support the use of context-rich visuals and integrated reporting techniques given their perceived benefit in conveying place-based information that might otherwise be excluded or overlooked in conventional reporting methods.

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Acknowledgements

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1. Introduction

1.1 Global climate change and the Arctic context

The year 2017 marked a milestone in global climate change observations. According to a 2018 Intergovernmental Panel on Climate Change (IPCC) Special Report, global warming resulting from human activities reached approximately 1 degree C (± .2 degrees C) above pre-industrial levels. An additional 0.5 degrees C increase, projected to be reached globally between 2030 and 2050, is the estimated threshold at which significant impacts to ecosystem services (environmental processes with direct benefit to society) are likely to occur (IPCC, 2018). The Arctic, however, is warming at a rate of 2 to 3 times faster than the global average and experiencing significant impacts today (IPCC, 2018). In addition to warming air temperatures, scientists and local residents have observed rapid declines in sea ice extent and quality, with future sea ice expected to be thinner, more salty, less rigid, and more mobile than today's (AMAP, 2017) (Wainwright personal communications, 2015). Arctic coastal communities are particularly sensitive to these changes due to high dependence on temperature-critical ecosystem characteristics such as local land and marine resources, stable permafrost, and reliable ice conditions for hunting, transportation, and other activities (Berner *et al.*, 2016). Among Arctic indigenous peoples, access to traditional local food sources is as critical for social and cultural wellbeing as it is necessary to meet economic and dietary needs (Nuttall *et al.*, 2005). This is particularly true given the remote nature of Arctic settlements, resulting in a high cost of living and limited access to outside resources (Brubaker *et al.*, 2014; NSB, 2015). To add to this complex dynamic, the impacts of climate change happen within the broader context of other issues affecting the Arctic, including globalization of culture, oil and natural gas development, mineral extraction, Arctic shipping and marine tourism, as well as demands of Arctic residents to have greater agency in decision-making that affects their way of life (Armitage, 2014; Schroeder, 2010; Trainor *et al.*, 2017).

1.2 **Rationale**

Iñupiat communities on the North Slope (the northernmost region of Alaska) face numerous challenges and opportunities related to climate change impacts and resource development activities, which have the potential to greatly influence Indigenous ways of life. Though these changes pose significant local impacts, most planning and decision-making activities happen outside local communities, and instead involve numerous other actors such as government agencies, industry, and non-government organizations (NGOs) situated at various spatial and jurisdictional scales. Decision-making bodies are increasingly decentralized allowing for greater incorporation of civil society actors in environmental governance (Lemos & Agrawal, 2006). However, the agency of local actors remains limited (ibid.). The full and effective engagement of Indigenous peoples and local communities in, and the contribution of their knowledge to environmental governance is constrained by numerous factors. Accordingly, this research was undertaken to gain an understanding of flaws in governance that may hinder the ability of local actors to collaborate on equal footing. While there are many points at which this topic may be explored, this research targets three fundamental challenges related to information and communication failures; informational challenges related to differences in scale, the challenge of interpreting contributions that are difficult to quantify, and developing synergies across knowledge systems. Scholars have suggested various institutional responses that address aspects of these challenges (e.g. knowledge co-production, co-management, ecosystem-based management). In addition to institutional reform, there is significant research that looks at the activities, tools, and organizations that function as intermediaries between various arenas and scales (Cash *et al.*, 2006; McGreavy *et al.*, 2013). This reported work is closely aligned with the latter through a focus on *boundary work* which, in the field of sustainability science, broadly encompasses activities of those seeking to mediate between knowledge and action (Clark *et al.*, 2016). The challenge of operationalizing diverse knowledge systems in governance is informed in this research by the Multiple Evidence Base Approach, which emphasizes both the separateness and complementarity of Indigenous, local, and Western knowledge systems (Tengö *et al.*, 2014). This

conceptualization is consistent with that put forth by Fikret Berkes in his widely cited work *Sacred Ecology* (Berkes, 2012) and by Cochran *et al* as part of their multi-pronged approach to broadening indigenous participation in climate change research in Alaska (Cochran *et al.*, 2013). Furthermore, this research also engages the tools (e.g. frame works, visuals, reporting methods) used by practitioners, and explores the influence of these tools in either facilitating or hindering the transmission of knowledge between diverse groups.

1.3 **Theoretical basis**

1.3.1 Sustainability science

This research is situated in the field of sustainability science, which is a transdisciplinary endeavor that acknowledges and attempts to engage the interconnections between society and ecology (McGreavy *et al.*, 2013). This description highlights two major concepts in the field. The first, *transdisciplinarity*, is a research approach that reaches beyond interdisciplinary initiatives in that it incorporates partners outside of academia including communities, NGOs, and industry (Lang *et al.*, 2012). Transdisciplinary research often focuses on societal problems with the goal of developing practical knowledge for application. The second concept, *social-environmental systems*, reimagines the relationship between humans and nature as intertwined rather than separate. People depend on resources and services provided by ecosystems, while ecosystem dynamics are in turn influenced by human activities (Chapin III *et al.*, 2009). Social-ecological systems are characterized by the interactions between humans and nature across time (e.g. short-term, long-term) and spatial (e.g. local, regional, national, international) scales (McGreavy *et al.*, 2013).

Governance

The complexity of social-environmental systems engages a diverse range of stakeholders including representatives from local communities, academia, industry, state and federal agencies, and from various

disciplinary backgrounds. The diversity of actors involved necessitates consideration of the broader social contexts that enable the management of complex systems (Folke *et al.*, 2005; Pahl-Wostl, 2009). Governance of social-environmental systems goes beyond state actions to include the system of organizations and institutions (e.g. rules, laws, regulations, policies, social and cultural norms) involved in governing environmental resources with a focus on negotiating and decision-making processes undertaken by networks and individuals (Chaffin *et al.*, 2014). Research to address the challenge of aligning local scale priorities with broadly focused governance initiatives primarily suggests reform to formal institutions, with greater agency of local actors and participatory management regimes proposed as solutions (Armitage *et al.*, 2009; Berkes, 2009; Lemos & Agrawal, 2006). However, an understudied challenge in environmental governance is a misalignment in communication between diverse actors who approach challenges with different levels of information and from different mental modes of understanding, which are each individual's set of assumptions for how the world works (Van Wyk *et al.*, 2008). Tensions arise at the interface between communities with different views of what constitutes reliable or useful knowledge (McGreavy *et al.*, 2013). The generation, transmission, and use of knowledge in the governance of complex social-environmental systems happens amidst uncertainty, incomplete understanding, and lack of agreement among diverse actors on what constitutes reliable and useful knowledge (McGreavy *et al.*, 2013; Van Wyk *et al.*, 2008). While the research reported in this dissertation focuses on interactions between local and larger scale entities, it should be noted that inequality and divergent viewpoints also exist within communities, making considerations for representation and agency in decision-making relevant across all scales (Lemos, 2008).

Boundary work

Scholarship in the sustainability sciences has extensively described the boundaries (e.g. methodology, nomenclature, imbalances in information) that exist between academic disciplines, cultural groups, and fields of practice (Clark *et al.*, 2016; McGreavy *et al.*, 2013; Van Wyk *et al.*, 2008). The term *boundary work* refers to the work of intermediaries who perform bridging activities, including the important task of

transmitting knowledge across differences in epistemology (academia), worldview (culture), and scale (knowledge-to policy) (Cash *et al.*, 2006; McGreavy *et al.*, 2013). *Boundary objects*, like visuals, are a key element that enables these activities. They are objects that provide a means of communicating and cooperating symbolically, thus inhabiting several intersecting social worlds while satisfying the informational requirements of each (Star & Griesemer, 1989). For example, maps are considered boundary objects given their capacity to create a common ground of understanding that all participants can build upon (McGreavy *et al.*, 2013; Star & Griesemer, 1989). While the communication-related dimensions of boundary work remain understudied in sustainability scholarship, visual and media studies offer theories and methodologies that can contribute to these efforts (McGreavy *et al.*, 2013).

1.3.2 Knowledge and environmental policy

The term "knowledge process" encompasses the full range of roles that knowledge can play in the environmental policy process, including the generation, transmission, and use of knowledge. Knowledge generation entails gathering, interpreting, theorizing, modeling, and synthesizing information. The pool of participants who generate knowledge for environmental decision-making is diverse including universities, community groups, industry, nonprofit organizations, tribal councils etc. Knowledge is then *transmitted* from its point of generation and *used* as an input in decision-making. Transmission occurs through a diverse set of channels including technical journal articles, popular media, congressional testimonies, or coffee shop conversations. In the process of being transmitted, there is a selective filtering of knowledge involving screening (not all knowledge is transmitted) and framing (shaping the way the issue is presented). Knowledge use activities are also varied, ranging from bringing an issue onto the active policy agenda, helping to formulate policy options, choosing to enact a particular policy, and then evaluating the performance of that policy (Ascher *et al.*, 2010). Activities related to knowledge generation, transmission, and use all play prominently into the research described within this dissertation.

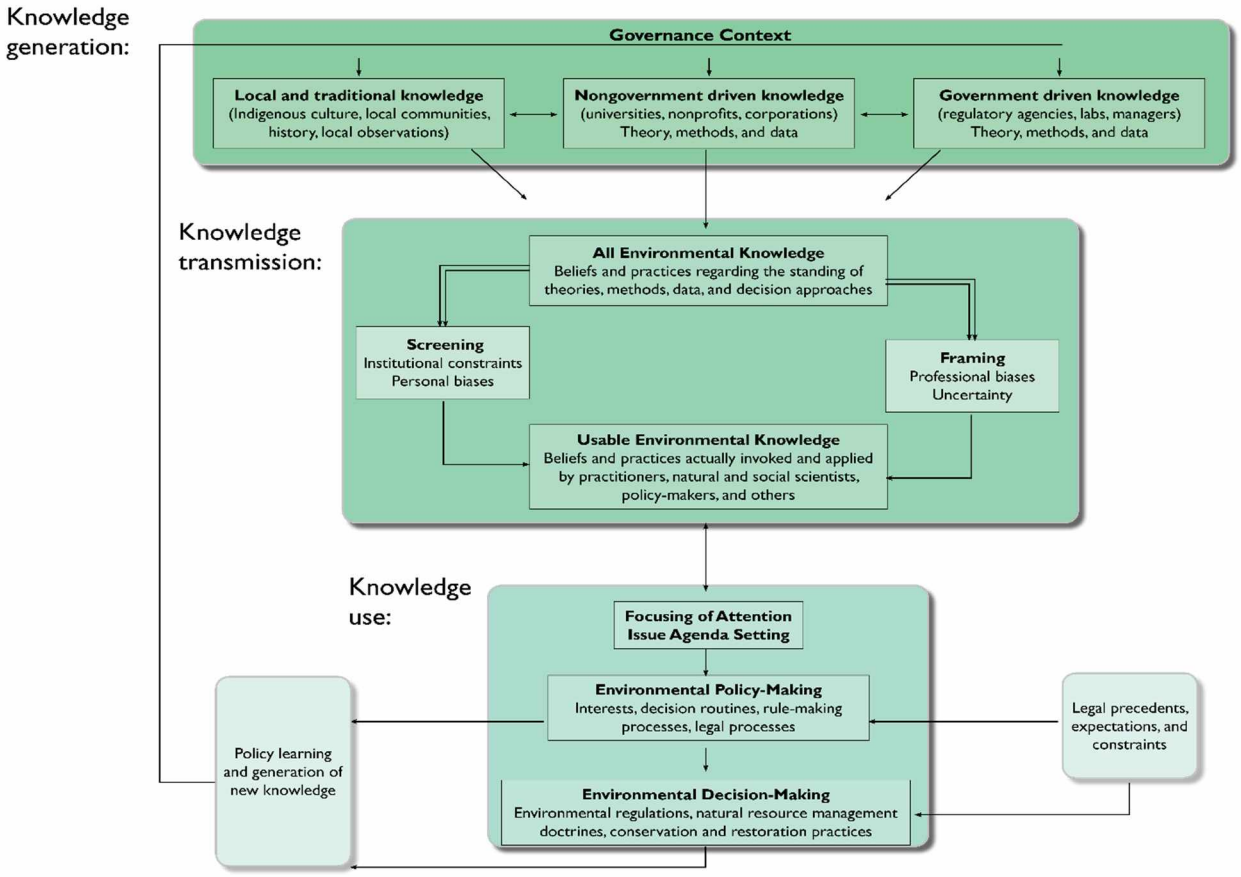

Figure 1.1: Knowledge generation, transmission, and use. Adapted from (Ascher et al., 2010)

Knowledge generation:

Local knowledge is defined as knowledge generated through observations of the local environment and held by a specific group of people. Indigenous knowledge is local knowledge held by Indigenous peoples or local knowledge unique to a given culture or society (Berkes, 2012). These knowledge systems are characterized as context specific and encompassing long time scales of observation, which is complementary to conventional management practices having strengths in the collection of synchronic data (Berkes & Folke, 2002). Social science of local and indigenous knowledge, which fits into the broader category of place-based research, is also important. *Place-based research* focuses on the context of specific social-ecological systems (Balvanera *et al.*, 2017). It recognizes the unique characteristics of local entities, while also addressing the impacts of global forces on them (ibid.). Natural resource

management as framed in the field of sustainability science and social-ecological systems conceptualizes human and environmental systems as interconnected rather than separate. As such, it is necessary to incorporate both scientific and social data into the process (Raymond-Yakoubian *et al.*, 2017). However, information from Western science remains dominant in decision-making processes (Lemos, 2008; Martin, 2007). Knowledge co-production and participatory research methods are among the significant efforts that have been made to increase representation of local actors in knowledge generation (Armitage *et al.*, 2011; Dale & Armitage, 2011; Robards *et al.*, 2018).

Knowledge transmission:

Scholarship in the sustainability sciences has extensively described the boundaries that exist between different cultural groups, as well as the organizations, objects, and spanning activities that are engaged in bridging these divides. However, sustainability sciences as a field needs to expand its discussion of communication-related dimensions, which vary depending on the context in which they occur and the groups involved (McGreavy *et al.*, 2013). Communication of information is integral within adaptation processes to increase awareness and understanding, provide continuity, and constructively engage policy-makers, stakeholders, and the public (Moser & Ekstrom, 2010). This reported research is concerned with two major challenges related to knowledge transmission, the first being consideration for the end-user. Specifically, identification of the target audience, and the formats in which their interests are best served. Information passes between actors in a range of generally accepted formats (reports, narratives, graphs, charts, etc.), many of which are not appropriately matched to the intended audience. This is often the case when research findings are delivered to local communities and policy makers in the form of technical reports intended for academic audiences. In a similar vein, local observations of change and their implications for Indigenous peoples are complex concepts that can be difficult to communicate to outsiders who are not aware of particular cultural nuances, and who lack the geographic frame of reference to understand the magnitude and scale of local environmental change.

A second concern is bounded rationality bias, a concept originally developed by Nobel Prize-winning economist Herbert Simon that explains the condition in which people make reasonable decisions based on the information they possess, despite having imperfect or insufficient information (Meadows & Wright, 2008). For example, the dominance of technical information in decision-making arenas means that other sources, like local and traditional knowledge, are marginalized or screened out of the portfolio of usable knowledge for decision-making (Lemos, 2008; Martin, 2007).

Knowledge use:

Challenges related to the application of local/Indigenous knowledge and place-based research include 1) local issues may not be relevant at global scales due to contrasts in worldviews, perceptions, or needs; 2) conventional standards question the credibility of non-Western knowledge sources; 3) place-based spatial and temporal scales are often mismatched with global sustainability research; and 4) upscaling place-based research is hindered by a limited understanding of why, when, and how place-based insight can be exported to other relevant scales (Balvanera *et al.*, 2017; Galaz *et al.*, 2008).

Bounded rationality is also implicated in activities related to the use of environmental knowledge. Though decision-makers are strongly motivated by a desire to optimize performance, the use of information in organizations is tethered to collective meaning, identity, and serving organizational goals (Rayner *et al.*, 2005). Decision-makers may be experts within their own departments or disciplines, but it is unlikely that they have adequate knowledge about the full range of social and environmental factors at play within each development decision they make. For this reason, transdisciplinary collaboration and knowledge sharing are key. Resistance to change and complexity are principal barriers affecting the use of new information in organizations (Rayner *et al.*, 2005). Externally generated information often does not fit well within existing decision-making tools that are already well-accepted and frequently requires the participation of an "expert translator" (ibid.). Furthermore, the incentive structure for many managers does not provide rewards for innovation, thus discouraging many from deviating away from accepted norms (Rayner *et al.*, 2005). Use of non-conventional knowledge sources for decision-making may be incentivized from higher

organizational levels as shown in the example of the Bureau of Ocean Energy Management revised tribal consultation guidance with Alaska Native Claims Settlement Act (ANCSA) Corporations, which defines enhanced provisions for the department's consultation process with Alaska Native tribes (BOEM, 2018).

1.3.3 Adaptation

Adaptation to climate change in social-ecological systems is the process of adjustment to actual or expected climate and its effects, which either seek to moderate or avoid harm, or to exploit beneficial opportunities (IPCC, 2014). Similarly, adaptive capacity refers to the preconditions that are necessary to enable adaptation (Nelson et al, 2007). Elements of adaptive capacity (stocks/assets) are distinct from adaptation actions (flows), which have time specific inputs or outcomes (Berman *et al.*, 2017). Adaptive capacity includes assets, such as social characteristics and physical and economic elements, which increase the effectiveness of adaptation actions (ibid.).

While this reported research focused on climate change as the primary stimulus for adaptation, adaptation actions rarely address climate risks or opportunities alone. Instead actions are undertaken with other goals in mind (such as economic gain or food security) while also achieving climate related co-benefits (Noble *et al.*, 2014; Smit & Wandel, 2006). For this reason, the adaptation dimensions identified within this dissertation are not specific to climate change impacts in isolation, but to social and environmental changes in general. Furthermore, this research looked beyond adaptation stimulated by challenges to also incorporate adaptation to exploit opportunities that may arise as a result of climate change, such as tourism or an increased availability of certain game animals.

The process of adaptation involves a number of actions that can be taken in support of decision-making (Figure 1.2). This research focuses on activities that build the capacity to adapt that are related to analysis of adaptation options and informational support (see box 4 Figure 1.2).

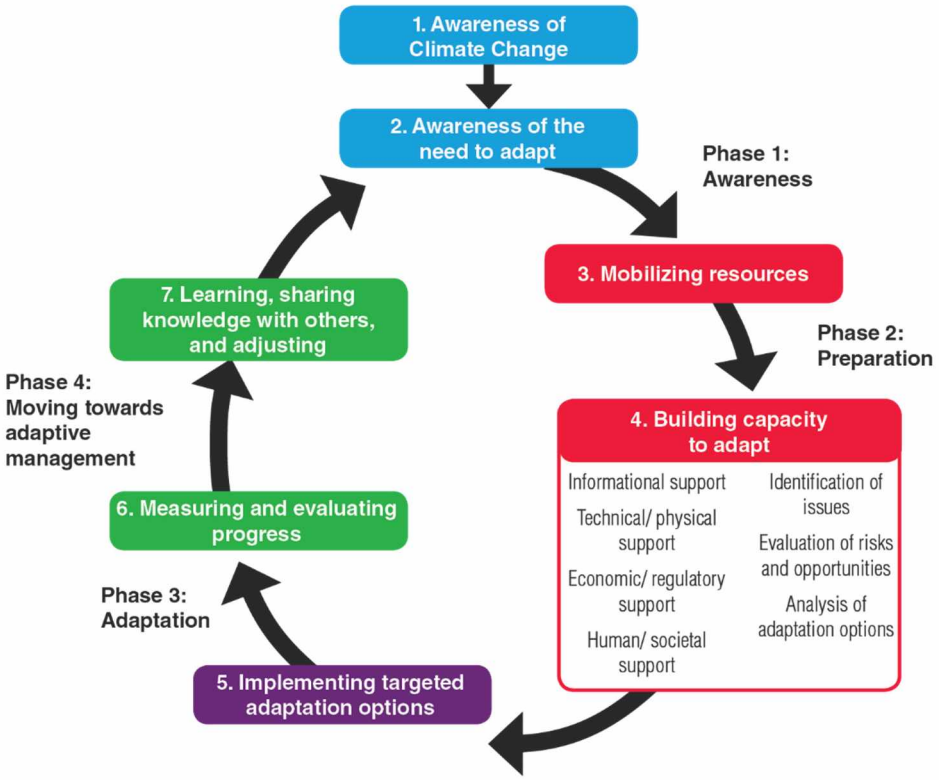

Figure 1.2: Stages and steps in the adaptation process. (Eyzaguirre & Warren, 2014)

1.4 Study area: Wainwright, Alaska

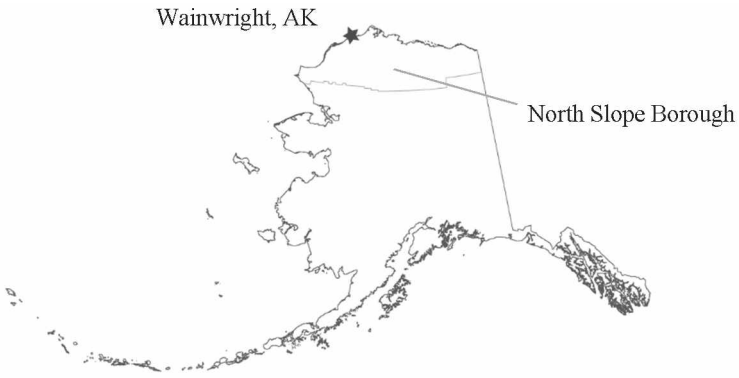

Figure 1.3: Native Village of Wainwright in the Alaska North Slope Borough

This research was conducted in collaboration with the Native Village of Wainwright (traditionally Ulguniq), an Alaska Inupiat community located on the state's northwestern coast approximately 120 kilometers (75 miles) by air southwest of Utqiagvik (formerly Barrow, Alaska). With an estimated population of 560, Wainwright is the third largest village in the North Slope Borough (Department of Labor, 2018). Approximately 90% of Wainwright residents are Inupiat (NSB, 2015) descended from the Kuugmiut, people of the Kuuk River,

and the Utuqqaġmiut of the Utukok River (Ivie & Schneider, 1988; Wainwright, 2016). Prior to the 20th century, people lived in a series of small, semi-permanent settlements along the coast and river drainages, subsisting on both ocean and inland resources, and moving as their needs dictated (Nelson, 1982). In 1904, a school was established in Wainwright by the Alaska Native Service (Wainwright, 2016). The reliable resources of the area drew people from their inland winter settlements, and Wainwright eventually became the only community in the region (Nelson, 1982).

Wainwright has undergone significant transformation over the last century. The development of oil resources at Prudhoe Bay and the subsequent 1971 establishment of the North Slope Borough (NSB) with its ability to tax oil industry facilities, brought an influx of funds to the region (Knapp & Morehouse, 1991). Through its Borough-wide Capital Improvement Program (CIP), the NSB invested tens of millions of dollars annually in schools, community halls, water and sanitation facilities, public health programs, and other public services (ibid.). Wainwright today is a modern community. Even so, traditional values remain central to the Iñupiat way of life. In particular, subsistence resources and the activities associated with the harvest of these resources establish and promote fundamental values in Iñupiat culture including generosity, respect for the knowledge of Elders, self-esteem for successful harvest, and public appreciation for sharing the harvest (NSB, 2015).

The Wainwright economy is part cash, part subsistence-based. Between 2008 and 2009, 85 percent of households supported themselves on a combination of subsistence, employment, and some other source of income such as retirement or dividend payments (Kofinas *et al.*, 2016). People must have income to be able to purchase outside goods and maintain the standard of life to which they are accustomed. The same purchasing power also provides access to the fuel, supplies, and equipment essential for modern subsistence activities (e.g. boats, snow machines, firearms, warm clothing). Still, even with access to outside goods, high transportation costs associated with the village's remote location result in exorbitant prices (NSB, 2015). Without connection to road networks, air travel is the only reliable year-round

transportation to and from Wainwright. As a result, people rely on subsistence resources to fulfill a large portion of their nutritional needs (Kofinas *et al.*, 2016).

Like many northern communities, Wainwright is already experiencing the effects of climate change. The climate is becoming warmer with an observed increase in average annual temperature of 2.5°C (4.6°F) over historical averages (SNAP, 2019). This warming has resulted in decreases in snow and ice, with delayed fall accumulation and early spring time melt (AMAP, 2017). This affects conditions for travel and access to subsistence resources. Residents are also observing a shift in animal migratory patterns, eroding shorelines, thawing permafrost, and a number of other environmental changes. The task of responding to environmental uncertainty is further nuanced by varied economic challenges and opportunities including the prospects of arctic shipping, tourism, and resource extraction. The Iñupiat demonstrate tremendous resilience, as exemplified by their long history in the Alaskan Arctic. However, communities still require support and collaboration from outside resources to fund local initiatives, provide information, and enact policies that strengthen local adaptive capacity.

1.5 **Methodology**

This research followed UAF Institutional Review Board (IRB) guidelines for the respectful conduct of research in Indigenous communities (IRB, 2019), which defer to the guidelines established by the recognized tribal governing body of a village. The study and its methodology are the outcome of an iterative process developed and conducted in partnership with the Wainwright Traditional Council and with guidance from a project steering committee comprising three local leaders (IRB approval letters available in Appendix A of this dissertation). This partnership was formally established through a resolution with the Traditional Council (Appendix B of this dissertation) with the goal of creating an environment of mutual respect for multiple ways of knowing and to foster beneficial research outcomes from both Western and Indigenous perspectives (Cochran *et al.*, 2013). Effective communication was

established and maintained with consistent updates to both the Traditional Council and the Wainwright Steering Committee, comprising leaders from the Traditional Council, City, and the Olgoonik village corporation. Project findings were validated over the course of the project with consultation from the Traditional Council and members of the project steering committee.

The data collection and analysis process described below are common across the three manuscripts that comprise this dissertation. Methods that were specific to each study are detailed in their respective chapters.

1.5.1 Data collection

Interviews (15) were conducted with 17 long-term residents from the Village of Wainwright. Selection criteria for interview participants included community members that self-reported as (1) being age 40 or older, (2) residing in Wainwright the majority of their lives, and (3) having significant experience outdoors in the Wainwright Traditional Use Area. Local Elders (10) were the primary target group given their ability to provide rich, first-hand information, covering a long time scale. An Elder is distinguished from an elderly person based on their recognized leadership in their community, including leading by example and sharing knowledge (Topkok, 2015). Middle-aged community members (7) who self-identified as having substantial knowledge of the outdoors were also interviewed. Initially, interview participants were recommended by the project steering committee. Additional participants were identified based on suggestions from the initial participants, a process called snowball sampling (Denzin & Lincoln, 2011). A combination "Senior Potluck" and pre-project community meeting was co-hosted by project researchers, the Wainwright Traditional Council, and the City of Wainwright. The purpose of the event was to introduce the research, receive feedback, and collect contact information from potential interview participants.

Semi-structured, in-depth interviews (Denzin & Lincoln, 2011) focused on each participant's observations of change throughout their lifetime as well as family and community scale adaptations in

response to unexpected events, environmental changes, economic development, and other factors. Interview questions were reviewed for appropriateness by project steering committee members and the draft interview protocol was pre-tested prior to being finalized. A local high school student residing in Wainwright was hired to assist with recording the interviews. Researchers provided an overview of the project and acquired written consent from each participant before starting each interview. Native Iñupiaq[1] speakers were given the option to conduct their interview in Iñupiaq with the assistance of a translator. Five participants chose this option. Out of the 17 participants, eight identified as being female and nine as being male. Two interviews were multi-person, both comprising husband and wife couples that requested a joint interview. Researchers ceased conducting interviews after a point of saturation was reached, where the collection of additional data produced no new insights on the issues being investigated (Glaser *et al.*, 1968).

1.5.2 Data analysis

The interviews were transcribed verbatim, and then coded and analyzed using NVivo (version 11) qualitative data analysis software. The coding process involved assigning segments of interview text into categories describing major themes being represented (Bazeley, 2013). Transcription and coding were performed by the first author and a student research assistant. Per directed content analysis (Hsieh & Shannon, 2005), initial codes were developed *a priori* based on input from the project steering committee and a literature review of social and natural science research pertaining to environmental and social changes in the Wainwright area (Braund, 2013; Brubaker *et al.*, 2014; Kassam, 2009; Kassam & Council, 2001; Sakakibara, 2010). These codes were then compiled into a draft codebook. A data subset,

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[1] Iñupiaq is singular and Iñupiat is plural. Iñupiaq may also be used to refer to the culture and the language of the Iñupiat people (ANLC).

comprising a selection of three representative interviews (20% of total conducted), was used for codebook pretesting and to test intercoder agreement. This step was conducted to ensure the codebook was comprehensive, and that each team member could independently replicate each other's work (Carey *et al.*, 1996). Per directed content analysis, the draft codebook was refined using emergent themes identified in the data subset during the first round of coding. Intercoder agreement was measured directly within NVivo using the Cohen's Kappa statistic. Kappa was used to assess coding reliability above and beyond agreement due to chance. Kappa revealed an "almost perfect" average agreement of 95% (70% minimum and 100% maximum) (Landis & Koch, 1977). Once a working codebook was developed, each team member independently coded the full data set.

Two additional rounds of coding based on existing theory of adaptation classification (paper 1) (Agrawal, 2010; Noble *et al.*, 2014), and informal institutions (paper 2) (North Slope Borough School District, 2008) (*Inupiat Ilitqusiat: Yesterday, Today & Tomorrow*, 1981) were conducted after this initial round of coding. Additional detail specific to these studies is available in Chapters 2 and 3 respectively.

1.6 Summary of papers

The three papers comprising this dissertation examine complementary approaches to better integrate local context into information used for the management of change and future uncertainty in the context of Arctic climate change governance.

The first paper addresses the challenge of bringing local specificity to adaptation planning processes initiated or sponsored by high level entities (knowledge generation and knowledge transmission [see Section 1.3.2]). It focuses on a specific step in adaptation planning: the analysis of adaptation options, which occurs prior to the selection and implementation of adaptation actions. The study identified information not captured in conventional, low resolution approaches, which demonstrates the value-added of a place-based approach to adaptation classification. The findings support an argument for increased

focus on local autonomous adaptations in addition to outside initiatives (Thornton & Manasfi, 2010). The methodology of directed content analysis used to identify discrepancies between low resolution and place-based adaptation approaches may also provide a means of scaling up local insights if employed successfully in comparative regional studies (Balvanera *et al.*, 2017).

The second paper explores the relationships between informal institutions and adaptation in Wainwright, AK. The specific contribution of informal institutions in adaptation is understudied. This is, in part, because they are difficult to identify, measure, and quantify, and often relate to elements of a society's culture from which many disciplines shy away (De Soysa & Jütting, 2006). Qualitative contextual analysis is employed to identify patterns of informal institution and adaptation associations in historic and contemporary situations in Wainwright. The Adaptation Institutional Analysis Framework developed in this paper extends Elinor Ostrom's Institutional Analysis and Development Framework (Ostrom, 2005) and is used as a tool to analyze and describe these dynamics. The findings from this study contribute to an improved understanding of the function and potential of informal institutions in adaptation processes, the benefits of which may extend beyond the local context of Wainwright, AK.

The third paper addresses the challenge of translating local scale information to outside audiences, specifically public sector decision-makers. With a focus on practical application, public sector conventions for reporting place-based information to decision-makers, including the limitations associated with these conventions are explored. This study proposes a reporting approach that introduces two components outside of general conventions in public sector information dissemination; 1) the application of context-rich images to help convey the social and cultural nuances of place-based information, and 2) the presentation of information from Western science and local/Indigenous knowledge systems alongside one another in the same report. A formative study was conducted to validate the research methodology involving a survey and follow-up interviews with upper-level public sector practitioners. Study results indicated a potential for significant benefits from the use of context-rich images in addition to local quotes for reporting information about the local context and experience of

Northern environmental changes. Additionally, several potential improvements to the content and design of the research methodology were identified for the benefit of future studies.

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2. Place-based Classification of Adaptation; Wainwright, AK case study[1]

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Abstract

Mismatches between the broad scale of what is known and the precise scale at which actions are taken is a significant challenge in global climate change governance. Generalized, low-resolution analyses such as methods of classifying adaptation opportunities are suited to international scales, yet may be missing key aspects of local adaptation that support the ability of communities to navigate change. Using a case study of the Native Village of Wainwright in the Alaskan Arctic, researchers applied a place-based approach (engaging the particularities of globally influenced, yet specific local places) to a generalized classification of adaptation. The goal of this research was to identify differences in the scope of analysis afforded by a place-based versus a generalized approach. This was achieved using directed content analysis of past and contemporary experiences of adaptation in Wainwright, wherein emergent classification themes revealed local nuances that were not captured by the general method. These findings demonstrate the relevance of a place-based approach to adaptation classification and also support increased availability of usable place-based knowledge to inform culturally relevant adaptation initiatives.

2.1 Introduction

Global climate change literature has been critiqued for its focus on planned adaptations and generalized technological fixes while the ongoing actions undertaken by individuals, cultures, and societies throughout history and into present day are often overlooked (Agrawal, 2010; D. R. Nelson et al., 2007; Thornton & Manasfi, 2010). This bias is, in part, a symptom of the broad scale and diverse actors involved in international negotiated efforts to plan and enact measures that facilitate adaptation to climate change. Many of the tools utilized within this process reflect the same bias with adaptation classification frameworks being no exception. Given adaptation can take potentially innumerable forms, it is useful to classify potential adaptation measures using an overall framework to help policy and decision-makers identify suitable focal areas (Burton, 1996; Feenstra et al., 1998). While many top-down classification approaches focus on planned adaptation measures that originate outside of local communities, complementary knowledge may be gained from an approach that seeks to understand and classify aspects of adaptation that already exist within communities. This research looked to the Arctic as the ideal setting to examine the knowledge gaps left by conventional, top-down classification approaches that might, in turn, be addressed through place-based methodology.

Arctic Indigenous peoples are not strangers to change, having survived numerous environmental shocks throughout their long history in the region (Armitage, 2014). The Iñupiat are believed to have continuously inhabited the Alaskan Arctic for 7,000 years, surviving extreme cold, fluctuations in climatic conditions, and periods of resource scarcity including food shortage (resulting in hunger) and famine (resulting in starvation and death) (Minc & Smith, 1989; Spencer, 1959). The sustained resilience of Arctic communities stems from long-term cultural adaptations to environmental change and uncertainty developed over the millennia (Armitage, 2014). These include cultural assets, such as comprehensive knowledge of the local environment and close-knit social networks built on collaboration and sharing (ibid.). However, the unprecedented magnitude and speed of change taking place today presents a new variable for communities to contend with (Brubaker et al., 2014). While northern

individuals and households may take some adaptive actions on their own as they have in the past, many important measures require the resources of government and other outside entities that are far removed from local communities both spatially and culturally (Johnson, 2011; Swaffield & Primdahl, 2006).

Local level climate change adaptation can be constrained by policy, regulation, or lack of funding at higher scales (Braund, 2018; Loring et al., 2011; Trainor et al., 2017). While many laws and agencies play a role in researching, guiding, and coordinating adaptation actions, local needs are often mismatched with the responsibilities, jurisdiction, and resources available at different scales of decision-making (Klein et al., 2014; Trainor et al., 2017). Additionally, details about the local context of change and magnitude of response necessary to achieve adaptation objectives is often misunderstood (ibid.). To strengthen the capacity of northern populations, governments and other external actors need to understand, take advantage of, and strengthen already existing strategies that many households and social groups use individually or collectively (Agrawal, 2010; Armitage, 2014; Blair, 2014; Naess, 2013). One avenue of operationalizing these intentions is place-based social-ecological research, which is optimally situated to explore interactions between local and global scales (Balvanera et al., 2017).

Place-based social-ecological research involves knowledge exchange across disciplinary boundaries and engages different stakeholders to address sustainability challenges in particular places (Balvanera *et al.*, 2017). This line of research simultaneously acknowledges the distinctness of local places and their existence as part of an interconnected global system (ibid.). The study reported here contributes to the growing body of place-based social-ecological research and also to scholarship focusing on specific adaptation options or measures for social-ecological systems impacted by climate change (Barry Smit & Wandel, 2006). It is unique because it applies a place-based approach to the reductionist logic of adaptation classification, providing a method that links local scale research with frameworks used in global climate change governance. The place-based classification of adaptation developed from this study is a bottom-up approach to adaptation classification based on a case study of historic and contemporary adaptations (both autonomous and planned) from the Native Village of Wainwright, a coastal Iñupiat

village on Alaska's North Slope. Directed content analysis of semi-structured, in-depth interviews was employed with the goal of highlighting fundamental similarities and differences between a place-based and a generalized approach to adaptation classification in the context of Wainwright. In doing so, the potential benefits of a place-based methodology for adaptation policy and planning efforts are also revealed. The paper is organized as follows. Section 2 provides an overview of the study area, Wainwright, Alaska. Section 3 summarizes key adaptation concepts, including the local context of adaptation in Wainwright, and precedent adaptation classification approaches. Section 4 details the directed content analysis method used to identify discrepancies between place-based and conventional classification approaches. Section 5 summarizes insights from the research and potential applications of place-based classification in adaptation planning efforts.

2.1.1 Study area

This research was conducted in collaboration with the Native Village of Wainwright (traditionally Ulġuniq), an Alaska Iñupiat community located on the state's northwestern coast approximately 120 kilometers (75 miles) by air southwest of Utqiagvik (formerly Barrow, Alaska). With an estimated population of 560, Wainwright is the third largest village in the North Slope Borough (Department of Labor, 2018). Approximately ninety percent of Wainwright residents are Iñupiat (NSB, 2015) descended from the Kuugmiut, people of the Kuuk River, and the Utuqqaġmiut of the Utukok River (Ivie & Schneider, 1988; Wainwright, 2016). Prior to the 20th century, people lived in a series of small, semi-permanent settlements along the coast and river drainages, subsisting on both ocean and inland resources, and moving as their needs dictated (Richard K. Nelson, 1982). In 1904 a school was established in Wainwright by the Alaska Native Service (Wainwright, 2016). The reliable resources of the

Figure 2.1: Wainwright, Alaska and the North Slope Borough boundary line

area drew people from their inland winter settlements and Wainwright eventually became the only community in the region (Richard K. Nelson, 1982).

Wainwright has undergone significant transformation over the last 115 years. The development of oil resources at Prudhoe Bay and the subsequent 1971 establishment of the North Slope Borough (NSB) with its ability to tax oil industry facilities, brought an influx of funds to the region (Knapp et al., 2014). Through its Borough-wide Capital Improvement Program (CIP), the NSB invested tens of millions annually in schools, community halls, water and sanitation facilities, public health programs, and other public services (Luton, 1985). Wainwright today is a modern community. Even so, traditional values remain a central to the Iñupiat way of life. In particular, subsistence resources and the activities associated with the harvest of these resources establish and promote fundamental values in Iñupiat culture including generosity, respect for the knowledge of Elders, self-esteem for successful harvest, and public appreciation for the sharing of the harvest (NSB, 2015).

The Wainwright economy is part cash-, part subsistence-based. Between 2008 and 2009, 85 percent of households supported themselves on a combination of subsistence, employment, and some other source of income such as retirement or dividend payments (Kofinas et al., 2016). People must have income to be able to purchase outside goods and maintain the standard of life they are accustomed to living. The same purchasing power also provides access to the fuel, supplies, and equipment essential for modern subsistence activities (e.g. boats, snow machines, firearms, warm clothing). Still, even with access to outside goods, high transportation costs associated with the village's remote location result in high prices (NSB, 2015). Without connection to road networks, air travel is the only reliable year-round transportation to and from Wainwright. As a result, people rely on subsistence resources to fulfill a large portion of their nutritional needs (Kofinas et al., 2016).

Like many northern communities, Wainwright is already experiencing the effects of climate change. The climate is becoming warmer with an observed increase in average annual temperature of 2.5°C (4.6°F) over historical averages (SNAP, 2019). This warming has resulted in decreases in snow and ice, with

delayed fall accumulation and early spring time melt (AMAP, 2017). This affects conditions for travel and access to subsistence resources. Locals are also observing a shift in animal migratory patterns, eroding shorelines, thawing permafrost, and a number of other environmental changes (Personal communication, 2015). Many Wainwright residents see themselves as inherently flexible and adaptable, having the capacity and mental fortitude to deal with change as it comes (D2015, personal communication, 2015). Some are not convinced the changes they are observing result from climate change, but regardless see a need to address new challenges and opportunities, and to take a more long-term perspective in planning that considers the needs of future generations in addition to those of the people alive today (Local advisor, personal communication, 2018). The task of responding to environmental uncertainty is nuanced by varied economic challenges and opportunities including globalization, the prospects of arctic shipping, tourism, and resource extraction. This challenge is further compounded by the impacts of colonization and assimilative U.S. policies, which have undermined the resilience of Iñupiat culture, and manifest today in Iñupiat-driven imperatives for the preservation of native language and other aspects of cultural identity (Adger et al., 2011; Barnhardt, 2011; *Inupiat Ilitqusiat: Yesterday, Today & Tomorrow*, 1981; North Slope Borough School District, 2008). The Iñupiat have a tremendous resilience, as exemplified by their long history in the Alaskan Arctic. However, communities still rely on support and collaboration from outside resources to fund local initiatives, provide information, and enact policies that strengthen local adaptive capacity.

2.1.2 Adaptation key concepts

Adaptation to climate change in social-ecological systems is the process of adjusting to actual or expected climate and its effects, which either seek to moderate or avoid harm, or to exploit beneficial opportunities (IPCC, 2014). Similarly, adaptive capacity refers to the preconditions that are necessary to enable adaptation (Nelson et al, 2007). Elements of adaptive capacity (stocks/assets) are distinct from adaptation actions (flows), which have time specific inputs or outcomes (Berman et al., 2017). Adaptive capacity

includes assets, such as social characteristics and physical and economic elements, which increase the effectiveness of adaptation actions (ibid.). The local context of adaptation can be categorized on the basis of the following three main categories, which effectively bound the scope of this research: 1) who or what adapts, 2) the stimulus for the adaptation, and 3) the process that it takes (Barry Smit & Pilifosova, 2003). The context of adaptation in Wainwright is conceptualized within this study as follows:

Who or what adapts: This study examined adaptation at and across multiple local scales from individual to household to community. It was necessary to address all three of these scales given the communal nature of Iñupiaq society in which the distinction between these scales is often blurred. For example, individuals may hunt in cooperation with others for the benefit of their respective households, with the parallel objective of providing for those in need throughout the community.

Stimulus for adaptation: While this study focused on climate change as the primary stimulus for adaptation, adaptation actions rarely address climate risks or opportunities alone. Instead actions are undertaken with other goals in mind (such as economic gain or food security) while also achieving climate related co-benefits (Noble et al., 2014; Barry Smit & Wandel, 2006). That is to say, regardless of the stimulus for action, the intended goals are largely consistent. For this reason, the adaptation categories identified by this study are not specific to climate change impacts in isolation, but to social and environmental changes in general. Furthermore, this study looked beyond adaptation stimulated by challenges, and also incorporated adaptation to exploit opportunities that may arise as a result of climate change, such as tourism or an increase in availability of certain game animals.

Process: Adaptation processes differ by their purposefulness (e.g. autonomous vs. planned), by the timing of actions (e.g. reactive vs. proactive), and by the temporal scope (e.g. short-term vs. long-term) (B. Smit & Pilifosova, 2001). *Autonomous adaptations* are initiatives undertaken by private actors that occur "naturally" without intervention from public institutions, while *planned adaptations* are usually the result of deliberate, centrally planned policy decisions (B. Smit & Pilifosova, 2001; Trainor et al., 2017). Autonomous adaptations tend to be *reactive*, with no action taken in the absence of a catalyst or trigger

indicating a significant threat or opportunity (B. Smit & Pilifosova, 2001). Planned adaptation measures are associated with *proactive/anticipatory* adaptations that are enacted or influenced by governments or collectives for the purpose of reducing vulnerability through efforts that diminish risk or increase adaptive capacity (UNFCCC, 1992).

While the importance of planned adaptation measures is indisputable, autonomous actions and local capacity are considered the most effective starting points for developing adaptation policy that is culturally sensitive and suited to the local context (Davies, 1993; B. Smit & Pilifosova, 2001). Furthermore, suitability to local context impacts the longevity of implemented measures as individuals have a tendency to circumvent rules that fail to fit their plans or traditions (Balvanera et al., 2017; Naess, 2013). It should be noted, however, that autonomous adaptations are not flawless, given processes taking place at the local level can be maladaptive, ultimately leaving people worse off. Furthermore, they are not inherently just or equitable (Naess, 2013; Thornton & Manasfi, 2010). Autonomous adaptation can also be more expensive, more disruptive, and less effective than planned adaptation initiatives as issues that demand early or long-term attention will often not receive it (Johnson, 2011; Barry Smit & Pilifosova, 2003). For these reasons, autonomous adaptations are not considered here as stand-alone measures, but rather as indispensable components of sustainable planned adaptation initiatives.

With respect to temporal scope, the nature of climate change involves significant levels of variability within long-term average conditions. Autonomous responses to variable conditions are sometimes characterized as *short-term* coping strategies that are distinct from adaptation, which involves a *long-term/permanent* change in the suite of strategies practiced to address variability (Davies, 1993). However, a repetition of coping responses caused by the reoccurrence of atypical environmental conditions (long-term variability) or permanent environmental change blurs the distinction between short-term and long-term adaptation, as well as the distinction between reactive and proactive adaptation (Agrawal, 2010). For this reason, the distinction between short- and long-term adaptation was not a focus of this study.

2.1.3 Adaptation classification: general frameworks and the logic of a place-based approach

There are several different approaches to understanding and classifying adaptation in the published literature to date. Local scale qualitative research produces rich, in-depth findings that are context-specific yet not easily transferred to other locales or larger scales (Balvanera *et al.*, 2017; Gelo *et al.*, 2008). On the other hand, generalized frameworks for adaptation classification are synthetic, having the ability to combine diverse components of adaptation into manageable categories that are more readily engaged at higher levels of analysis (Agrawal, 2008, 2010). Generalized classification approaches have been applied broadly to global datasets (Agrawal, 2008, 2010; Burton, 1996; Noble *et al.*, 2014) and also to regional and local contexts (Berman, 2013; Goldman & Riosmena, 2013; Trainor *et al.*, 2017; Upton, 2012). Two precedents were chosen as models for the generalized classification developed as a baseline for this study; the Intergovernmental Panel on Climate Change (IPCC) Framework (2014) and Arun Agrawal's Classes of Adaptation Practice (2010). Both are widely cited approaches that respectively intersect with elements of adaptive capacity (stocks), and adaptation responses (flows). Key aspects of each precedent are summarized below.

The IPCC is a global body that assesses science related to climate change and functions as a primary scientific reference concerned with the environmental and social consequences of climate change. Given its global platform, the IPCC classification framework is a generalized approach that aims to account for diverse adaptation options representative of different sectors and stakeholders (Noble et al., 2014). The framework detailed in the IPCC Fifth Assessment Report on climate change (2014) is the most recent iteration, having evolved from its early conceptualizations (Burton, 1996 cited in; B. Smit & Pilifosova, 2001) to encompass the varying scales of influence active in contemporary global climate change governance (Noble et al., 2014). The IPCC Framework separates adaptation options into three major categories: (1) *Structural and Physical*, including structural and engineering options, the application of discrete technologies, leveraging ecosystem services, and the provision of health, medical, and other services; (2) *Social*, made up of educational, informational, and behavioral measures that target the

specific vulnerability of disadvantaged groups; and (3) *Institutional*, composing economic initiatives, legal and regulatory actions, and government policy and programs (Noble et al., 2014).

The second precedent, Agrawal's Classes of Adaptation Practice, is an analytical classification of observed adaptation practices specific to rural stakeholders at the community and household scale (Agrawal, 2010). It advances a framework put forth by Halstead and O'Shea in 1989, which outlined basic categories of "buffering mechanisms" employed in hunter-gatherer and agrarian societies to reduce the risk of food scarcity caused by environmental variability. The five categories in Agrawal's classification are (1) *Mobility*, the distribution of risk across space; (2) *Storage,* the distribution of risk across time; (3) *Diversification,* the distribution of risk across asset classes; (4) *Communal pooling,* the distribution of risk across households; and (5) *Market exchange,* the purchase and sale of risk via contracts (Agrawal, 2008, 2010; Halstead & O'Shea, 1989)(Agrawal, 2008; Halstead & O'Shea, 1989). Agrawal applied this classification to an international dataset (118 cases) of coping and adaptation strategies related to climatic and environmental variability, sourced from the United Nations Framework Convention on Climate Change (UNFCCC). The case subjects were poor, rural, agrarian and pastoralist societies, primarily from countries in Asia (58) and Africa (45). His analysis provided a means to examine the role of local institutions (civic, public, and private) in facilitating adaptation and also their role in mediating between external interventions and improvements in local adaptive capacity (Agrawal, 2010).

Agrawal's classification synthesizes patterns observed in a large number of cases for comparative analysis. It focuses on the household and community scale, but it also generalizes across an international dataset. In contrast, the place-based approach taken in this reported study is a detailed analysis of a single case intended to identify aspects of local adaptation that are likely to be overlooked in a conventional generalized approach. Such missing dimensions represent one of several potential contributions of place-based adaptation classification in regional scale initiatives; making valuable local insights and lessons learned more accessible to outsiders. Additionally, these insights may be readily scaled to national and global levels through comparative studies (Balvanera et al., 2017). Other benefits of a place-based

approach include support for the co-construction of solutions with local communities, providing a means of better integrating local and indigenous knowledge into decision-making (Balvanera et al., 2017), and added tractability to In-depth studies of potentially complex relations between environmental, economic, and social processes driven by global change (Wilbanks & Kates, 1999). Discrepancies between generalized and place-based adaptation classification approaches were identified using a three-step directed content analysis method, detailed in the methodology section below (Hsieh & Shannon, 2005).

2.2 **Methodology**

This study and its methodology are the outcome of an iterative process developed and conducted in partnership with the Wainwright Traditional Council and with guidance from a project steering committee comprising three local leaders. Interviews (15) were conducted with 17 long-term residents from the Village of Wainwright. Selection criteria for interview participants included community members that (1) were age 40 or older, (2) had resided in Wainwright the majority of their lives, and (3) had significant experience outdoors in the Wainwright Traditional Use Area. Local Elders (10) were the primary target group given their ability to provide rich, first-hand information, covering a long time scale. An Elder is distinguished from an elderly person based on their recognized leadership in their community, including leading by example and sharing knowledge (Topkok, 2015). Middle-aged community members (7) identified as having substantial knowledge of the outdoors were also interviewed. Initially, interview participants were recommended by the project steering committee. Additional participants were identified based on suggestions from the initial participants, a process called snowball sampling (Denzin & Lincoln, 2011). Information sessions including the combination "Senior Potluck" and pre-project community meeting were co-hosted by project researchers, the Wainwright Traditional Council, and the City of Wainwright as a forum to receive feedback, and collect contact information from the pool of potential interview participants.

2.2.1 Data collection

Semi-structured, in-depth interviews (Denzin & Lincoln, 2011) focused on each participant's observations of change throughout their lifetime as well as family and community scale adaptations in response to unexpected events, environmental changes, economic development, and other factors. Interview questions were reviewed for appropriateness by project steering committee members and the draft interview protocol was pilot-tested prior to being finalized. A local high school student residing in Wainwright was hired to assist with recording the interviews. Researchers provided an overview of the project and acquired written consent from each participant before starting each interview. Native Iñupiaq speakers were given the option to conduct their interview in Iñupiaq with the assistance of a translator. Five participants chose this option. Out of the 17 participants, eight were female and nine were male. Two interviews were multi-person, both comprising husband and wife couples that requested a joint interview. Researchers ceased conducting interviews after a point of saturation was reached, where the collection of additional data produced no new insights on the issues being investigated (Glaser et al., 1968).

2.2.2 Directed content analysis

The interviews were transcribed verbatim and then coded and analyzed using NVivo qualitative data analysis software (version 11). During coding, segments of interview text are matched with relevant categories (codes) derived from major research themes (Bazeley, 2013). The coding process followed the directed content analysis approach where initial coding was derived from existing theory (The IPCC Framework and Agrawal's 5 Classes of Adaptation Practice) and relevant research findings (Hsieh & Shannon, 2005). This method was selected to help determine the validity of the baseline generalized classification when applied in detail to a local community. The validity of the baseline classification is partially determined by its ability to capture the broad range of themes conveyed by interview participants. Modifications identified through the coding process (e.g. emergent codes, redefined code definitions) transformed the generalized classification into a place-based classification. The process of

developing the classification system was the data analysis. The final organizing system (the Place-based Classification of Adaptation) was the outcome of the analysis.

In step one of the directed content analysis approach, a generalized framework of adaptation was created based on Agrawal's 5 Classes of Adaptation Practice and the IPCC Framework. The generalized classification included two major categories *Adaptation Responses* and *Elements of Adaptive Capacity*, and nine sub-categories derived from these precedent frameworks.

Step two involved highlighting all text that, on first impression, appeared to represent aspects of adaptation (Hsieh & Shannon, 2005). This potentially broad list was bounded by the study scope detailed in *Adaptation Key Concepts* above.

In step three, the generalized framework from step one was used to code the segments of text highlighted in step two (Hsieh & Shannon, 2005).

Adaptation strategies described by interview participants included both direct adaptation responses and actions that contributed to local adaptive capacity. While participants did not distinguish between the two, the classification breaks them into separate categories for clarity and consistency with the terms as they are defined in the sustainability science literature (Berman, 2013; IPCC, 2014; D. R. Nelson et al., 2007). This separation was also made to identify patterns of association between adaptation, adaptive capacity, and informal institutions (see Chapter 3 of this dissertation).

The proposed classification sub-categories drew primarily from Agrawal's 5 Classes of Adaptation Practice (Agrawal, 2008, 2010) for adaptation response categories (Mobility, Storage, Diversification, Communal Pooling, Market Exchange) and from the IPCC Framework (Noble et al., 2014) for adaptive capacity categories (Infrastructure & Technology, Research/Knowledge/Observation, Educational/Behavioral, Institutional). As coding proceeded, emergent themes that did not fit into the proposed classification led to modifications in the definitions of existing categories or, if warranted, the

creation of new categories. The outcome of this process, the Place-based Classification of Adaptation, is presented in the results below.

2.3 **Results**

Table 2.1 summarizes the Place-based Classification categories and their operationalizations. Three categories (mobility, market exchange, and infrastructure & technology) were modified from the baseline classification. A detailed description of the modified categories is provided below. A description of all adaptation categories is available in Appendix A.

Table 2.1: Place-based Classification of Adaptation – Wainwright, Alaska

Adaptation categories		Description
Adaptation response options	1. Mobility	Physically moving through areas based on availability of resources. Also includes the timing and speed of movement
	2. Storage	Reduces risk over time by balancing periods of abundance with periods of scarcity
	3. Diversification	As an adaptation practice, diversification can be applied in many different ways. It involves using alternative assets, resources, or skills to address risk and opportunity
	4. Communal Pooling	Members of a group working together with the objective of pooling their resources (e.g. food, hunting equipment, environmental knowledge, labor, income) to address risk or opportunity.
	5. Market exchange	Sale or trade of goods and services with local or outside markets. Also a general category for activities related to participation in the cash economy including wage labor, and purchasing goods.

Adaptation categories		Description
Elements of adaptive capacity	6. Infrastructure & Technology	Infrastructure improvement and technology that contribute to local adaptive capacity
	7. Research/ Knowledge/ Observation	Available knowledge that is considered meaningful to members of a community. Includes local observations, indigenous knowledge, Western science, or research into new technologies and strategies for adaptation.
	8. Educational/ Behavioral	Sharing knowledge through training, education (formal and informal), or information exchange with the goal of guiding or changing behavior (Feenstra et al., 1998)
	9. Institutional	Formal* organizations, rules, and regulations of any scale (local, regional, state) that impact adaptive capacity (Noble et al., 2014).

* Informal institutions (socially shared rules such as social or cultural norms that exist outside of officially sanctioned channels) are also elements of adaptive capacity but are a category too large to address within the scope of this paper. For a detailed analysis of informal institutions see Chapter 3 of this dissertation.

2.3.1 Emergent themes

Mobility as an adaptation strategy is a means of addressing risk and responding to opportunity through movement. It encompasses physically moving between areas of localized resource abundance (Agrawal, 2008, 2010; Minc & Smith, 1989). This category was broadened to also include the timing and speed of movement, which were prominent themes in Wainwright due to changes in the timing of subsistence hunting resulting from economic and environmental change.

Adaptations related to mobility were discussed by 93% (14/15) of participants. These adaptations were in relation to both environmental and economic challenges/opportunities. For example, food shortages in the past happened during times when animals were scarce in traditional hunting grounds. People responded by increasing their hunting range, traveling further, or staying out longer. Today, faster boats, snow machines, and four-wheelers are among the technologies that allow people to travel faster and further (*Infrastructure & Technology*). However, economic factors, including the high cost of fuel and the responsibilities of employment, make it difficult for people to stay out hunting for long periods. In response to this, hunters in Wainwright have become accustomed to making quick trips. One Elder said:

> In the past "… when they went hunting they stayed up there or they stayed down there or somewhere till they got enough you know, instead of just going up there over the weekend and coming right back maybe with nothing but when they go hunting they waited for the animals and got them and bring them back." – (Interview O, 2015)

Furthermore, the window of opportunity for certain hunting activities has become smaller due to the increasingly early arrival of spring and loss of sea ice (SNAP, 2016). Hunters have responded by condensing hunting activities into a shorter time frame and making sure they are ready to go at a moment's notice. In reference to walrus hunting, one participant noted:

> "What used to be like, maybe a two or three week period of hunting, you're cramming it into maybe a week or week and a half… this year was a week. The ice was here and it was gone… no more than 10 days it was nearby." – (Interview N, 2015)

Mobility in relation to outmigration was mentioned by two interview participants in reference to the collapse of the fur trade in the 1930s and the lack of local jobs (Interview B, 2015). The population of Wainwright declined from the late 1940s to the early 1950s as people moved to Utqiagvik to look for work (Luton, 1985). According to the 2003 Survey of Living Conditions in the Arctic (SLiCA), only 38% of Alaska Iñupiat who live in villages and settlements have considered moving in the last five years (Poppel et al., 2007). The primary reasons people decide to stay in their community are family ties and social support (ibid.). Commuting for work is a common practice, though one Elder mentioned the unwillingness of young people to be away from the village as a challenge that prevented them from pursuing economic opportunities:

> "…there's opportunities out there that are open. The main problem is people that graduate from here tend to live here. And they don't want to go anyplace else. There's a few that, during the uh, ahm, the oil industry, when it was being pretty big we had people that worked two weeks on, two weeks off. And those were very few. And I wish that younger people would do the same. Get their training, get their qualifications and just go. Two weeks on, two weeks off, or three on three off" – (Interview B, 2015)

Mobility as an adaptation is closely related to the *Research/Knowledge/Observation* component of adaptive capacity. Within pastoralist and subsistence-oriented societies, high value is placed on information to monitor environmental variability over a large area beyond the normal annual spatial range and outside of customary annual temporal patterns (Agrawal, 2010; Halstead & O'Shea, 1989).

Market exchange is the sale or trade of goods and services with local or outside markets. The definition was broadened per interview data analysis to include all instances of engagement with the cash economy, including wage labor and consumer activity. This was necessitated by the mixed subsistence-cash economy that exists in Wainwright and other North Slope communities, with both components (subsistence and income) essential for survival and well-being. In 2009, 85% of Wainwright households (113 of 133) made a living combining subsistence with employment and retirement/dividend income (Kofinas et al., 2016). In contrast, the Inupiat of the Wainwright area were largely isolated until the beginning of the 20th century, almost completely dependent on subsistence and using locally-sourced, handmade gear (Bodfish Sr., 1991). The coexistence of subsistence and capitalism create a unique economic and cultural dynamic that residents are continually navigating. For this reason, activities like finding a job or purchasing imported supplies that are not considered adaptation in precedent studies (Agrawal, 2010), are highlighted in Wainwright.

For example, people have to work to afford the supplies and fuel needed to hunt. Hunters have adapted by taking short trips instead of staying out on the land for prolonged periods of time. This is made possible, in part, by the adoption of outside technologies such as snow machines, modern outboard motors, etc. These allow people to travel faster, but also cost money to maintain and repair (*Mobility-Market exchange*).

Diversification and *Market Exchange* are closely related adaptation responses. The fur trade was a major industry in Wainwright during the early 1900s (Chance, 1990). People traded furs for goods or sold them

for cash/credit at the local store. Collapse of the fur trade during the Great Depression of the 1930s was a major economic shock for the community (Chance, 1990). Employment opportunities were scarce locally. Some with skills were able to find jobs as carpenters or laborers. Some moved to Utqiagvik for work (*Mobility-Market exchange*). Others adapted by returning to a subsistence-only lifestyle.

Access to outside markets has allowed people to purchase supplies and gear that used to be handmade. However, some noted a decline in quality of clothing despite the convenience of store-bought clothes. As one participant shared:

> "…when we were growing up we had warm caribou boots made out of caribou legs, which were called tuttulik caribou they were very warm. But nowadays we have basketball shoes with a lot of holes in them. Everybody is catching cold and we didn't have no problem with what our parents or grandparents sewed together for us to use for the cold winters." – (Interview B, 2015)

Still, goods are expensive in Wainwright and across the North Slope (NSB, 2015). Having healthy locally sourced food options remains essential for nutritional and cultural well-being.

Infrastructure & Technology is a broad category for infrastructural improvements and technologies that contribute to local adaptive capacity. The IPCC framework describes a similar category, *Structural & Physical*, which includes discrete activities with a collective objective, clear outputs and outcomes, and well-defined spatial and temporal parameters (Noble et al., 2014). Examples of discrete activities that have been employed in Wainwright include the construction of a sea wall to protect the shoreline from erosion and design specifications for houses on raised foundations as protection from water damage. However, a number of technological advances such as Global Positioning System (GPS) devices, snow machines, and social media services, feature prominently into participant accounts of adaptation, but do not fit within the narrowly defined IPCC category. This shows how advances that are significant at the individual and community level can be left out of generalized analyses.

Modern technology has led to vastly improved communication capacity in North Slope Alaska. In the past, before cell phones and before VHF radio, whaling crews communicated with people in the village using a system of flags. Today, whaling crews can send updates to people in town using their cell phones if they are within range. Social media platforms like Facebook are widely used in North Slope communities and help people keep in touch with friends and family living in other villages. Social media is helpful for sharing news about environmental observations. This is increasingly important as seasonal migration patterns have changed with warming temperatures. Hunters know when the animals are headed their way once people in neighboring communities have started seeing them.

2.3.2 Adaptation patterns

The Place-based Classification of Adaptation organizes a wide range of local adaptation responses and elements of adaptive capacity into a manageable set of units. Table 2.2 shows the number of participants that referred to actions or qualities associated with each adaptation category. These numbers are not reported as an indication of importance, but rather to help illustrate interesting patterns that emerge from the data. *Communal pooling* and *Mobility* were the most commonly mentioned adaptation categories (14 out of 15 informants), followed by *Diversification* and *Market exchange* (13 out of 15 informants). Additionally some adaptation categories frequently occurred simultaneously in relation to the same event. Therefore, the examples provided are not discreet and can be relevant to more than one category (Agrawal, 2010; Noble et al., 2014).

Table 2.2: Occurrence of adaptation categories (the number of interviews in which each adaptation category was endorsed)

Adaptation categories		Examples	# of Interviews/ (out of 15)
Adaptation response options	1. Mobility	- Extending hunting range during food shortage - Adjustment from long to short hunting trips due to employment responsibilities - Greater preparedness and urgency stimulated by shorter window of opportunity for hunting walrus - Decision to stay local or move outside the community for economic opportunity	14
	2. Storage	- Large quantities of food traditionally stored in ice cellars. Means of moderating periods of resource availability to with periods of scarcity - Freezers have provided a suitable, but not equivalent alternative as many ice cellars fail	4
	3. Diversification	- Pursuing alternative livelihoods, like reindeer herding - Adoption of snow machines as an alternative means of transportation to dog teams - Diversification of traditional family roles to allow households to access multiple resources that overlap in timing of availability	13
	4. Communal Pooling	- Sharing food - Helping Elders with chores - Hunting as a group with family or hunting partners - Pooling money to support those in need	14
	5. Market exchange	- People must work to obtain fuel and other supplies necessary for subsistence - Ability to purchase gear and supplies that used to be handmade	13
Elements of adaptive capacity	6. Infrastructure & Technology	- Sea wall to protect shoreline from erosion - Houses built on raised platforms to protect from flooding - Adopting modern technologies that address local needs	11
	7. Research/ Knowledge/ Observation	- Pride and respect earned for having deep knowledge of one's environment - People rely on local and indigenous knowledge as well as information from outside sources, such as weather reports - Information collection and sharing is important for making informed decisions (e.g. safety during hunting, decisions local leaders make that impact the community)	12

Adaptation categories		Examples	# of Interviews/ (out of 15)
	8. Educational/ Behavioral	- Teaching young people cultural norms like always helping Elders - Information exchanged by learning from parents and grandparents	10
	9. Institutional	- Regional initiatives (e.g. North Slope Borough Capital Improvement Program) - International representation (e.g. Inuit Circumpolar Council, Alaska Eskimo Whaling Commission) - Regulations can adversely affect adaptive capacity (e.g. conservation measures that restrict ability to hunt non-threatened species)	11

The prominence of a category is determined by a few primary factors including the range of events and conditions for which an aspect of adaptation can be applied, the frequency with which those events and conditions occur, and the number of people directly involved. The four most widely endorsed adaptation categories rank highly in all three of these categories. For example, *Communal pooling* has a wide range of potential applications ranging from helping out (e.g. sharing food, helping with chores, raising money) to cooperative hunting, to mounting a unified response to an injustice. Of all the potential applications of this category, some are part of everyday life and happen very frequently (e.g. helping out and cooperative hunting). Finally, joint action by members of a group is the defining characteristic of *Communal pooling*, which inherently involves the direct participation of many people (Agrawal, 2010). *Storage*, in contrast, was only mentioned by four participants. It was mentioned primarily in relation to past actions like stockpiling coal and ice, and also in reference to the past and present use of ice cellars for food storage. However, while the loss of ice cellars would be a significant event with impacts for the entire community, only a few families actually own ice cellars and have direct responsibility for their upkeep (Brubaker et al., 2014).

Diversification-Market exchange, *Mobility-Research/ Knowledge/Observation*, and *Educational/ Behavioral-Institutional* were the three most commonly co-referenced categories (Table 2.3). *Market exchange*, in many cases, was a precursor for *Diversification*. For example, access to outside markets provided new means to make a living (e.g. trapping, wage employment) and also introduced non-local food options to the community. *Mobility* was often associated with *Research/ Knowledge/Observation* in relation to hunting and travel conditions. *Educational/ Behavioral* was associated with formal institutions, which are the source of many educational opportunities and informational campaigns. In contrast, some participants felt dividend payments and other institutional handouts had negative behavioral impacts for the few people who rely on them as a replacement for work. It should be noted that these associations are particular to the specific context of Wainwright and, while the same adaptations exist elsewhere, they are likely linked differently.

Table 2.3: Notable associations. Shows the number of times each adaptation category association was referenced (frequency) and the number of interviews in which the association was made out of a possible 15.

Adaptation category associations	Frequency	# of Interviews/ (out of 15)	Themes
Diversification-Market Exchange	16	9	- Access to outside markets providing opportunities for diversification (e.g. fur trade, different food options, transportation options, employment options) - Ability to rely on subsistence to supplement or replace (past) lack of money - Finding a balance between working and hunting
Mobility- Research/ Knowledge/Observation	9	8	- Knowledge of ice conditions for safe travel - Knowledge of where animals are so you know when to prepare to hunt - Knowledge of the land and how to reach a targeted location from multiple directions - Traveling to hunting camp as a learning opportunity for young people
Educational/ Behavioral-Institutional	9	6	- Relationship between formal education (e.g. schools, training programs) and opportunity - Potential for school or community-sponsored programs to teach hunting and other traditional values

Adaptation category associations	Frequency	# of Interviews/ (out of 15)	Themes
			- Potential relationship between "handouts" (e.g. dividend payments) and a lack of motivation among some

2.4 Discussion

Results from the directed content analysis of in-depth interviews offer supporting evidence for the relevance of a place-based classification in the case of Wainwright, Alaska. No new adaptation categories were added to the baseline as part of the process, however adjustment to several category definitions was necessary to accommodate the range of themes specific to the local culture and environment. Rather than contradicting the baseline classification, these modified definitions further refine and enrich the preliminary categories. These refinements offer insight into local characteristics that are not readily captured in more general adaptation analyses and demonstrate the value-added of a place-based approach to adaptation classification.

2.4.1 Discrepancies identified between generalized and place-based classification

Risk in the context of climate and other environmental changes is the focus of the two primary approaches that served as precedents for the Place-based Classification of Adaptation (Agrawal, 2008, 2010; Noble *et al.*, 2014). At the outset of this analysis, the focus of the proposed classification was widened beyond that of the precedent frameworks to also include adaptation as a means to address opportunity. This decision was made based on input from local advisors in Wainwright who emphasized the importance of positioning Wainwright so it has the ability to respond to challenges and also take advantage of opportunities when they arise (Local advisor, personal communication, 2015).

The mixed subsistence-cash economy that exists in Wainwright and other Alaska Iñupiat communities is a unique aspect of the local context that led to modifications in two categories of adaptation; *Mobility* and *Market exchange*. *Mobility* was broadened to include the timing and speed of movement in addition to the act of physically moving between areas of localized resource abundance. Adaptations in timing and speed were often mentioned in relation to uncertainty about when animals would arrive or how long they would remain in the vicinity. Timing and speed were also commonly associated with employment in reference to the impact of a normal work week on hunting practices (e.g. time spent on the land, speed of transportation for hunting).

Market exchange was initially defined narrowly based on Agrawal's Classes of Adaptation Practice as the sale or trade of goods and services with local or outside markets (Agrawal, 2008, 2010). It was broadened to include all actions related to participation in the cash economy including wage labor and purchasing goods. In addition to the local mixed subsistence-cash economy, the relatively recent introduction of capitalism to the region in the late 19th to early 20th century also impacts the scope of the *Market exchange* category (Chance, 1990). The shift from being entirely subsistence-reliant to trading and purchasing outside goods that quickly became essential household items was a major transformation in Iñupiat society that remains prominent in the living memory of Elders. Activities related to balancing a dual need for subsistence and income were frequently mentioned by interview participants in relation to both past and present-day life in Wainwright.

Infrastructure and technology was expanded to include technological advances not necessarily originated for the express purpose of adaptation, but that nevertheless have an impact on local adaptive capacity. This change increases the local relevance of the precedent IPCC framework category, *Structural and Physical*, which includes discrete interventions with clear outputs and outcomes. The addition of context-specific detail within this category provides useful information about existing technologies that already have widespread acceptance within a community or region and, for this reason, can potentially be leveraged in adaptation planning.

2.4.2 Comparison to precedent adaptation patterns

The results of the Place-based Classification of Adaptation applied to Wainwright (a remote, coastal, cash-subsistence society) show some similarities to Agrawal's 5 Classes of Adaptation Practice applied to a global database of cases from poor, rural, agrarian and pastoralist societies (Agrawal, 2008, 2010). The primary characteristics these groups share in common are rural location and local resource dependence. In both Wainwright and Agrawal's study set, *Communal pooling* stood out as the most widely mentioned adaptation. This may be an indicator of the broad significance of *Communal pooling* across diverse groups. Also similar to Agrawal, *Diversification* and *Market exchange* were frequently associated with one another in Wainwright. A notable difference between the two studies was the prevalence of *Mobility* as an adaptation response. Where in Agrawal's study *Mobility* was the least mentioned adaptation response, in Wainwright it was tied with *Communal pooling* in number of endorsements. This difference can be attributed, in part, to the modified definition of *Mobility*, which was broadened in this study to accommodate the nuances of a cash-subsistence society.

2.4.3 Applications

Place-based approaches to adaptation classification such as the Place-based Classification of Adaptation derived in this study have several applications in cross-scale adaptation initiatives.

First, the directed content analysis approach used to develop the Place-based Classification of Adaptation identified interesting local patterns that go beyond generic adaptation analyses. This demonstrates that there are details present in the local adaptation context that are not captured in large generalized frameworks. This is as true for adaptation classification as it is for other theoretical frameworks and models. A place-based approach widened the scope of analysis in Wainwright to include aspects of the mixed subsistence-cash economy that highlight timing and speed of movement as important factors for *Mobility* and that serve as an impetus for adaptations associated with balancing employment and hunting activities. These insights may help broaden the focus of adaptation planning initiatives that involve

subsistence-cash-based economies to include more culturally relevant strategies that support the ability of individuals and households to navigate context-specific challenges.

Second, the classification may provide a means of scaling up local insights if successfully applied in similar contexts (e.g. other North Slope communities, or mixed cash-subsistence economies) for comparative analysis. A central challenge in place-based research is that knowledge gained in a specific place or context is often not easily transferred to larger forums due to differing world views, perceptions, or needs (Ascher et al., 2010; Balvanera et al., 2017). For example, global drivers do not manifest uniformly in varied local contexts, which creates differing local narratives and diverse responses. At the global scale, comparison across sites is necessary to explore how local insights can be applied to sustainability goals (Balvanera et al., 2017). To this end, the regional scale can act as a conceptual bridge between local and global initiatives given many organizations and institutions that operate at the regional level are appropriately positioned to mobilize and synthesize information from multiple local cases, resulting in increased awareness of successful autonomous strategies among participants of regional, national, and global scale adaptation discourses (Balvanera et al., 2017). This may benefit local adaptation initiatives by refocusing policy discussions toward solutions that are culturally relevant and matched to local needs and capacity.

Third, the classification brings autonomous adaptations and locally-derived elements of adaptive capacity to the forefront of the analysis. To date, planned adaptations and technological fixes have been the primary focus within global climate change literature (Naess, 2013; D. R. Nelson et al., 2007; Thornton & Manasfi, 2010). In response, new institutional settings are arising along with a growing body of research initiated for the purpose of integrating place-based insights into global sustainability research and policy (Balvanera et al., 2017). Knowledge of autonomous adaptations and local adaptive capacity can improve the ability of decision-makers to evaluate planned anticipatory adaptation options, including key local assets that would benefit from outside support (Davies, 1993; B. Smit & Pilifosova, 2001). At the global scale, these details can provide local evidence and action-oriented knowledge to inform decisions. They

also provide a way to better understand the impact of environmental change on ecosystem services and improve understanding of global and local linkages (Wilbanks & Kates, 1999).

2.4.4 Future research needs

There is a need for more research on why, when, and how place-based insights such as those derived from the Place-based Classification of Adaptation can be exported to other similar scales, or scaled up to larger spatial and institutional scales (Balvanera et al., 2017). The Place-based Classification of Adaptation was developed based on local accounts from the Native Village of Wainwright; a remote, coastal, subsistence-cash oriented Iñupiat community in northern Alaska. The transferability of the classification to other communities with similar cultural and geographic characteristics, such as other coastal North Slope communities remains to be determined. While not intended to be used in a one-size-fits-all manner, there is potential for the classification to help create portfolios of solutions relevant for similar communities and regions if the range of contexts for which it applies is better understood (Seppelt et al., 2013; Václavík et al., 2013).

Participant representation is another issue that merits further exploration in future research efforts. This study focused on Wainwright Elders as the primary informant group given they are highly respected within the community and possess deep, long-term knowledge of the local environment and changes that have occurred over time. While this focus yielded rich information, it may have also skewed the research findings toward past adaptations rather than contemporary ones, which are also important given they are based on contemporary challenges and opportunities. Additionally, local advisors suggested that future research of this type should involve more youth as they are the ones that are going to be dealing with ongoing social and environmental changes as they progress.

2.5 Conclusion

The primary goal of this research was to determine the similarities and differences between a place-based and a conventional generalized approach to adaptation classification and, in doing so, identify potential benefits of a place-based methodology for adaptation policy and planning efforts. The discrepancies identified between the general and place-based classification were primarily linked to the subsistence-cash economy that is particular to Wainwright where residents are continuously balancing the dual need for subsistence and income. Adaptations specific to this unique local context included changes in timing and speed of movement enabled in part by technology (e.g. snow machines, increased availability of information), and necessitated by the responsibilities of employment in addition to ongoing changes in seasons and animal migration patterns. The contribution of basic technology as an element of adaptive capacity is another place-based insight that broadens the discussion of technological solutions beyond discrete interventions with clear outputs and outcomes to include general advances not necessarily created for the purpose of adaptation, but that nonetheless make a difference in people's everyday lives. Additionally, this research demonstrates the relevance of the directed content analysis method for identifying aspects of place-based adaptation. The method can be readily applied in adaptation initiatives that bridge local and regional scales.

Benefits of a place-based classification of adaptation include assisting the transfer of knowledge between social worlds, in this case an indigenous community and the external decision-makers that influence local capacity to adapt. The approach also provides information that expands the focus of discussion to include a community's history of adaptation and the key characteristics that contribute to adaptive capacity in the context of that community. A place-based classification may also help agencies and organizations draw parallels between the policies and regulations they oversee, and the local actions and elements of adaptive capacity that relate to them. This can provide important insights toward new focal areas for targeted policy to invest in adaptive capacity, proven local strategies that warrant increased support, and help identify maladaptive policies to be overhauled.

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Appendix A

Place-based classification of adaptation category descriptions:

Mobility as an adaptation strategy is a means of addressing risk and responding to opportunity through movement. It encompasses physically moving between areas of localized resource abundance (Agrawal, 2008, 2010; Minc & Smith, 1989). This category was broadened to also include the timing and speed of movement, which were prominent themes in Wainwright due to changes in the timing of subsistence hunting resulting from economic and environmental change.

Adaptations related to mobility were discussed by 93% (14/15) of participants. These adaptations were in relation to both environmental and economic challenges/opportunities. For example, food shortages in the past happened during times when animals were scarce in traditional hunting grounds. People responded by increasing their hunting range, traveling further or staying out longer than they normally would. Today, faster boats, snow machines, and four-wheelers are among the technologies that allow people to travel faster and further (*Infrastructure & Technology*). However, economic factors, including the high cost of fuel and the responsibilities of employment, make it difficult for people to stay out hunting for long periods. In response to this, hunters in Wainwright have become accustomed to making quick trips. In the past "*... when they went hunting they stayed up there or they stayed down there or somewhere till they got enough you know, instead of just going up there over the weekend and coming right back maybe with nothing but when they go hunting they waited for the animals and got them and bring them back.*" – O2015

Furthermore, the window of opportunity for certain hunting activities has become smaller due to the increasingly early arrival of spring and loss of sea ice (cite). Hunters have responded by condensing hunting activities into a shorter time frame and making sure they are ready to go at a moment's notice. In reference to walrus hunting, one participant said:

"*What used to be like, maybe a two or three week period of hunting, you're cramming it into maybe a week or week and a half... this year was a week. The ice was here and it was gone... no more than 10 days it was nearby.*" – N2015

Mobility in relation to outmigration was mentioned by two interview participants in reference to the collapse of the fur trade in the 1930s and the lack of local jobs (B2015). The population of Wainwright declined from the late 1940s to the early 1950s as people moved to Utqiagvik to look for work (Luton, 1985). According to the 2003 Survey of Living Conditions in the Arctic (SLiCA), only 38% of Alaska Iñuit who live in villages and settlements have considered moving in the last five years (Poppel et al., 2007). The primary reasons people decide to stay in their community are family ties and social support (ibid.). Commuting for work is a common practice, though one elder mentioned the unwillingness of young people to be away from the village as a challenge that prevented them from pursuing economic opportunities:

"... there's opportunities out there that are open. The main problem is people that graduate from here tend to live here. And they don't want to go anyplace else. There's a few that, during the uh, ahm, the oil industry, when it was being pretty big we had people that worked two weeks on, two weeks off. And those were very few. And I wish that younger people would do the same. Get their training, get their qualifications and just go. Two weeks on, two weeks off, or three on three off" – B2015

Mobility as an adaptation is closely related to the *Research/Knowledge/Observation* component of adaptive capacity. Within pastoralist and subsistence-oriented societies, high value is placed on information to monitor environmental variability over a large area beyond the normal annual spatial range and outside of customary annual temporal patterns (Agrawal, 2010; Halstead & O'Shea, 1989).

Storage as an adaptation practice reduces risk over time by balancing periods of relative resource abundance with periods of relative scarcity (Agrawal, 2010; Minc & Smith, 1989). The resources referenced by precedent studies in association with storage include food and water (Agrawal, 2010). This is consistent with the case of Wainwright, excepting the inclusion of energy as an additional category. This, however, is not considered a unique addition given the storage of energy resources (e.g. coal, oil,

wood) is common in many societies. Storage practices are effective in combination with reliable infrastructure and technology, and also with coordination across households (Agrawal, 2010).

Ice cellars, traditional underground cellars dug into permafrost (soil layers that are frozen year-round), have provided a reliable means of food storage for thousands of years in Wainwright and other North Slope communities (Brubaker et al., 2010). In addition to game, families stored ice that was cut from fresh water ponds in the winter to provide water throughout summer months. Even after households were connected to piped municipal water in the 1970s, some still preferred the flavor of water from stored ice to that of chlorinated City water.

However, warming soil temperatures, thawing permafrost, and erosion are reducing the reliability of ice cellars and causing many to be flooded or structurally unsound (Brubaker et al., 2010). This reduces the quality and quantity of food resources for some families (Ibid.). Furthermore, freezers are considered an inferior alternative given they require power, can hold less food, and have a reportedly negative impact on the taste of food.

"His family had an ice cellar that was passed down to him because he was a whaling captain. It got flooded from the runoff when the snow melted. Something about the drainage I guess. But now a lot of those ice cellars which used to be on the coast are not there anymore... Food that is stored in a freezer doesn't taste like food that is from an ice cellar" – M2015

The storage of energy resources, which took place historically in Wainwright, adds an additional facet to *Storage* as an adaptation strategy. Before the wide availability of stove oil in Wainwright in the 1960s (C2015), families primarily used coal for heating and cooking. Large amounts could be harvested from the beach after autumn storms. Coal could also harvested and transported by boat or dog team from one of three nearby mines along the Kuk River (Richard K Nelson, 1969)

Historically, stored ice and coal provided the added benefit of shielding homes from the weather (Storage + Technology & Infrastructure):

"The ice would be piled up around one side of the house, the coal would be piled up alongside, the side of the house but they acted like wind breakers to have a warm house" – O2015

Diversification as an adaptation practice is highly varied, often involving the use of alternative assets, resources, or skills to address risk or opportunity. This category also includes routine practices applied in a novel way as in, for example, job specialization, or intensification of production to boost yield (Agrawal, 2010; Thornton & Manasfi, 2010). *Diversification* strategies shared by participants were notably associated with periods of food shortage, hunting practices, traditional family roles, *Technology* and *Market Exchange*.

It is estimated that, in the 1960s, stored meat and blubber from the bowhead whale provided at least 50 percent of the winter food supply in coastal Inupiat communities (Foote & Williamson, 1966; Sheehan, 1985). Seals were the second most significant food source, while walrus, caribou, migratory birds, and fish provided the balance (Ibid.). Coastal communities were considered less vulnerable than interior communities to food shortage, due to the diversity of food sources available (Minc & Smith, 1989; Sheehan, 1985). However, in both regions, a failure in the primary food source could not be sufficiently mediated by secondary sources (Ibid.). An example of historic diversification catalyzed by food shortage in Wainwright is the adoption of reindeer herding as a livelihood strategy that came in response to the absence of caribou herds in the region in the late 1800s (Bodfish Sr., 1991). Another strategy was the use of emergency foods, foods not typically eaten when sufficient food is available, during times of famine (Halstead & O'Shea, 1989).

"*I don't know what year, when I was a little girl, I don't know what year, the caribous never come for a long time. But, ah, my dad, he's a hunter, he went hunting, whatever he can kill, or, you know, for food... one time he'd bring home seagulls, so my mom, uh, boil 'em, and cook 'em, and we ate 'em.*" L2015

The appearance of infrequently seen animal species in the North provides another opportunity for *Diversification* into new subsistence resources. Participants reported seeing moose, porcupine, otters, and

musk ox (rarely) within 40 miles of Wainwright, particularly when there are ongoing forest fires south of town. Wildfires are happening more frequently in northern Alaska as a result of warmer and drier summer conditions, frequent lightning strikes, and increasing shrub cover (Duffy et al., 2005; Joly et al., 2009)

Food security remains an issue in Wainwright, despite the availability of store-bought foods. In the year 2010, most households (96 percent) were not able to meet their nutritional needs with store-bought foods alone and 36 percent were unable to get enough subsistence foods (NSB, 2012)

Diversification of traditional family roles was an adaptation that traditionally allowed households to access multiple resources that overlapped in seasonal availability. In the spring, men traditionally hunted in the ocean while women gathered eggs or hunted water fowl.

"An example of that would be her mom and dad, my mom and dad and then our parent's friends they would go outside and go camping in the summer or spring time and then the men would hunt off in the ocean. The women would be gathering eggs or hunting brants or ducks and everybody shared and we don't see that anymore." B-2015

The adoption of snow machines as a means of transportation is an example of Diversification that also increased Mobility, in reference to speed of travel. Snow machines eventually replaced dog teams as the primary mode of transportation.

A modern example of *Diversification* is the ability to sell handicraft items to earn supplemental income. However, it is reported that local craftspeople are reluctant to take the next step of turning these "side gigs" into businesses. One advisor speculated that entrepreneurship training could provide the confidence and motivation people need to create local businesses.

Communal pooling is joint action by members of a group with the objective of pooling their resources (e.g. food, hunting equipment, labor, income) to address risk or opportunity. Successful *Communal pooling* requires functioning institutions (formal and informal) to coordinate activities across households and between communities (Agrawal, 2010).

Communal pooling is closely associated with the core values of cooperation and sharing in Iñupiaq culture (Alaska Native Knowledge Network).

"*Inupiat people… when they have to do something, they get together, they do it. You know, as a team. And Wainwright is like that. When it comes right down to it. You know, when the whole village have to act like one. The entire village, they will act like one, they will become one.*" – H2015

This strategy plays out in the harvesting, distribution, and sharing of traditional foods and is also observed in community efforts such as fundraising to help those in need.

Whaling is exemplary in all of these respects. The whaling captain is, among other things, responsible for providing supplies and gear, and organizing the crew. Members of the whaling crew donate their time to hunt, which also involves breaking trail and spending days on the ice at whaling camp. Other community members actively support whaling crews by providing funds, food, and transportation to and from camp. When a whale is killed, many people from the village come to help land and process the animal. The whaling captain's wife leads food preparation with assistance from family. Finally, everyone in the community joins in the whaling festival (*nalukataq*) and other celebrations where meat and blubber are distributed (Ivie & Schneider, 1988) (local advisor, 2018).

Based on 2009 harvest data, only 25 percent of average wild food inflows to Wainwright households was from their own harvest activity. The remaining 75 percent resulted from inter-household social relationships such as cooperative hunting, receiving shares, or gifting (Kofinas et al., 2016)

Formal institutions and extended social networks enable *Communal pooling* practices that span local, regional, and national scales. For example, Wainwright experienced difficult whaling conditions in 1992 that prevented local whalers from successfully taking a whale. In response, whaling regulations enabled Wainwright to transfer three strikes (referring to the quota for struck whales) to Utqiagvik where hunting conditions were more amenable. When whalers in Utqiagvik landed three whales, they sent muktuk and meat back to Wainwright (K2015).

Additionally, a significant amount of subsistence foods harvested in Wainwright are shared with households outside of the community. In 2015, 97 percent of Wainwright households shared subsistence foods with other households within their community, 51 percent shared with households in other North Slope Borough Communities, 49% percent shared with households in Anchorage and/or Fairbanks, and 12 percent shared with people from other Alaska communities or outside Alaska (NSB, 2015).

Participants shared numerous accounts of coming together to help community members in need. Hunters share food with Elders and families without hunters. It is also common for the community to pool money or organize a fund raiser to help people in need.

"*In order to make ends meet, especially for medical or for a funeral service, you know for immediate family, one of the things that our village still does is come together and help. And they do cake walks and stuff to fundraise or they do a little pool to fundraise and that's one of the major things that our village as a whole has not lost.*" – K2015

Market exchange is the sale or trade of goods and services with local or outside markets. The definition was broadened for this study to include all instances of engagement with the cash economy, including wage labor and consumer activity. This was necessitated by the mixed subsistence-cash economy that exists in Wainwright and other North Slope communities, with both components (subsistence and income) essential for survival and well-being. In 2009, 85% of Wainwright households (113 of 133) made a living combining subsistence with employment and retirement/dividend income (Kofinas et al., 2016). In contrast, the Iñupiat of the Wainwright area were largely isolated until the beginning of the 20th century, almost completely dependent on subsistence and using locally-sourced, handmade gear (Bodfish Sr., 1991). The coexistence of subsistence and capitalism create a unique economic and cultural dynamic that residents are continually navigating. For this reason, activities like finding a job or purchasing imported supplies that are not considered adaptation in precedent studies (Agrawal, 2010), are highlighted in Wainwright.

For example, people have to work to afford the supplies and fuel needed to hunt. Hunters have adapted by taking short trips instead of staying out on the land for prolonged periods of time. This is made possible, in part, by the adoption of outside technologies such as snow machines, modern outboard motors, etc. These allow people to travel faster, but also cost money to maintain and repair (*Mobility-Market exchange*).

Diversification and *Market Exchange* are closely related adaptation responses.

The fur trade was a major industry in Wainwright during the early 1900s (Chance, 1990). People traded furs for goods or sold them for cash/credit at the local store. Collapse of the fur trade during the Great Depression of the 1930s was a major economic shock for the community (Chance, 1990). Employment opportunities were scarce locally. Some with skills were able to find jobs as carpenters or laborers. Some moved to Utqiagvik for work (*Mobility-Market exchange*). Others adapted by returning to a subsistence-only lifestyle.

Access to outside markets has allowed people to purchase supplies and gear that used to be handmade. However, some noted a decline in quality of clothing despite the convenience of store-bought clothes. *"...when we were growing up we had warm caribou boots made out of caribou legs, which were called tuttulik caribou they were very warm. But nowadays we have basketball shoes with a lot of holes in them. Everybody is catching cold and we didn't have no problem with what our parents or grandparents sewed together for us to use for the cold winters."* B2015

Still, goods are expensive in Wainwright and across the North Slope (NSB, 2015). Having healthy locally sourced food options remains essential.

Infrastructure & Technology is a broad category for infrastructural improvements and technologies that contribute to local adaptive capacity. The IPCC framework describes a similar category, *Structural & Physical*, which includes discrete activities with a collective objective, clear outputs and outcomes, and

well-defined spatial and temporal parameters (Noble et al., 2014). Examples of discrete activities that have been employed in Wainwright include the construction of a sea wall to protect the shoreline from erosion and design specifications for houses on raised foundations as protection from water damage. However, a number of technological advances such as Global Positioning System (GPS) devices, snow machines, and social media services, feature prominently into participant accounts of adaptation, but do not fit within the narrowly defined IPCC category. This shows how advances that are significant at the individual and community level can be left out of generalized analyses.

Modern technology has led to vastly improved communication capacity in North Slope Alaska. In the past, before cell phones and before VHF radio, whaling crews communicated with people in the village using a system of flags. Today, whaling crews can send updates to people in town using their cell phones if they are within range. Social media platforms like Facebook are widely used in North Slope communities and help people keep in touch with friends and family living in other villages. Social media is helpful for sharing news about environmental observations. This is increasingly important as seasonal migration patterns have changed with warming temperatures. Hunters know when the animals are headed their way once people in neighboring communities have started seeing them.

The category ***Research/Knowledge/Observation*** includes the pool of available knowledge that has been validated and is considered meaningful to members of a community. This may include local observations, indigenous knowledge, Western science, or research into new technologies and strategies for adaptation (Feenstra et al., 1998; Thornton & Manasfi, 2010).

Research/Knowledge/Observation is closely associated with mobility and hunter success, a core Iñupiaq cultural value (Alaska Native Knowledge Network). There is great pride and respect that comes with knowing ones environment through a lifetime of lived experience, careful observation, and learning from Elders and other role models in the community.

"One more thing about caribou... three of us go hunt [together] all the time... With dog team, and when we go from here we meet up there somewhere. We know the land, where we gonna meet. No matter which way you go, we get together up there so we can camp together" G2015

Furthermore, *Observation* is more than just making a mental note. Because things are always changing, many hunters are in the habit of keeping journals to record environmental observations, including how many of what type of animal was caught during which time of year and at what location (Local advisor, 2018).

Information is also important for safety, helping hunters accurately evaluate risks and decide whether or not to hunt. In addition to local and indigenous knowledge, participants noted the importance of outside information sources. People regularly monitor the weather forecast and also look out for scientific research on things that impact their environment and way of life.

"...they're watching the weather, the sun, and the oceans. Using their information will help us to live safer and better with the weather, with the changing environment..." H2015

One participant noted the importance of reliable information so people can make informed decisions.

"...We all have to adapt to it, no matter what. Cause we can't change it. You know, there's nothing we can humanly do to change the environment around us. So you just need informed decisions..." N2015

Another participant also noted the necessity for outsiders (people from the state and federal government) to understand more about the way of life in the North Slope before they make decisions.

Educational/Behavioral refers to knowledge exchange through training, education (formal and informal), or information exchange with the intent of guiding or changing behavior (Feenstra et al., 1998). *Educational/Behavioral* initiatives are important for sharing knowledge about adaptation options and for helping to build social capital for increased adaptive capacity (Noble et al., 2014).

Closely related to *Research/Knowledge/Observation*, the crux of *Educational/Behavioral* is knowledge for action. A major activity within this category is teaching young people cultural norms like always helping Elders and others in the community. One participant noted the importance of influencing young people to get involved in the community and also the importance of education so the youth can become leaders and contribute to society.

"*... we can still go ahead and teach them what we used to do, how we used to do it, how we helped each other and I really stress that to the kids to never ignore anybody that needs help. Because they're able to help. And you make them feel good about themselves you know, it's something I try to stress to people and younger kids.*" – O2015

Also included in this category are the mechanisms for information exchange. These include learning from parents and grandparents, learning while out on the land, learning by watching and doing, and listening to stories about how things were in the past.

"*Long time ago we were learning by watching and as we got a little bit bigger they would tell us to start doing some delicacy stuff to the intestines of the walrus because we were anxious you know. It's um, and then we get to start skinning and um doing other things that the older women did but we had to learn how to observe and watch and see and do, you know.*" – O2015

For less fortunate youth who don't have the opportunity to learn about hunting from their immediate family, it was suggested that there should be programs to get them out on the land and involved in hunting.

"*But still, some kids hardly ever go out to go hunting because their parents don't go out hunting because they don't have the boat or the skidoos or, you know. But still you know, they should concentrate on getting those kids that are less fortunate to try and get 'em involved through the school or community to try and ah get them involved in hunting or something.*" – O2015

The ***Institutional*** component of adaptive capacity includes formal organizations, rules, and regulations of any scale (local, regional, state) that impact adaptive capacity. These may include economic instruments

(e.g. taxes, dividend payments, and insurance arrangements), social policies, planning measures, laws, or regulations (Noble et al., 2014).

Institutional organizations and measures have played a major role in enabling and catalyzing adaptation in Wainwright. For example, the Alaska Eskimo Whaling Commission (AEWC, established 1977) is the primary organization representing the needs and interests of Alaska Eskimo whalers. Among other responsibilities, the AEWC allocates the whaling quota limiting the number of whales that can be caught in a given timeframe among Alaskan whaling communities (Braund, 2018). The quota system is credited with catalyzing the transition from whaling with traditional seal skin boats to using outboard motors in Wainwright. The number of strikes initially allocated to Wainwright (based on historic bowhead harvest levels [1910-1969] and the village's Iñupiat population) was so small that whaling captains did not want to risk losing a whale that tried to run after being harpooned. Wainwright's small strike allocation persisted in subsequent years, which made the transition to outboard motors a permanent adaptation (personal communication, 2018).

The North Slope Borough Capital Improvement Program (CIP) was a regional institution active from the 1970s to the 1980s that supported local adaptive capacity in Wainwright. The CIP funded improved educational facilities, housing, health care services, sanitation and water supply systems, roads, etc. (Chance, 1990). Interview participants credited the CIP with providing employment opportunities and providing a means to fix damage caused by natural disasters such as a major storm in the late 1980s with strong winds that blew the roof off several houses in town (H,J,K2015).

Institutional measures may also have a negative impact on adaptive capacity. Examples cited by interview participants include hunting regulations that do not accurately reflect environmental conditions and are not flexible or responsive when conditions change.

"And sometimes white man rules were a little bit in the way because they let (sic.) us quit duck hunting because they were endangered but us people who live here all the time know that they are not really endangered but it was the white man's law." O2015

One advisor noted the adverse impacts associated with conservation measures such as a critical habitat listing for the spectacled eider. This listing restricts hunting of the eider and all other animals that live in the protected area, regardless of their species designation.

3. Informal Institutions and Adaptation: Patterns and pathways of influence in a remote Arctic community[1]

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Abstract

Institutions are influential in mediating the impact of adaptation initiatives at the local level, yet there are disconnects between the goals of multi-scale planning initiatives and community priorities. Research to address this challenge primarily focuses on reform to formal institutions in environmental governance. Meanwhile, knowledge of the specific role informal institutions play in governance processes remains limited. This study increases understanding of the interactions between informal institutions and adaptation using a case study of the Native Village of Wainwright on Alaska's North Slope. Qualitative contextual analysis was employed to identify patterns of informal institution and adaptation associations in historic and contemporary situations in Wainwright. The Adaptation Institutional Analysis Framework developed in this paper extends Elinor Ostrom's Institutional Analysis and Development Framework and is used as a tool to analyse and describe these dynamics. Four primary findings resulted from this analysis 1) identification of informal institutions that have a bearing on adaptation to environmental change and adaptive capacity in Wainwright, 2) insight into how the identified institutions relate to each other and to different aspects of local adaptation, 3) identification of changes in informal institutions that have occurred over time and the potential implications of these changes for local adaptive capacity, and 4) potential opportunities to leverage knowledge of informal institution and adaptation relationships in targeted formal initiatives. The outcomes of this study contribute to an improved understanding of the function and potential of informal institutions in adaptation processes, the benefits of which extend beyond the local context of Wainwright.

3.1 Introduction

Institutions shape human behaviour and are a significant force influencing how individuals and households adapt to environmental change. Numerous scholars have examined the institutional contexts of collective actions and policy outcomes, but the analytical distinctions between formal and informal institutions as part of this process are largely neglected (Agrawal, 2010; Ostrom, 2005). Informal institutions can be difficult to identify, measure, and quantify (De Soysa & Jütting, 2006). Furthermore, the functioning of formal and informal institutions in relation to adaptation is closely coupled and, for actors on the ground, the distinction is easily blurred (Amaru & Chhetri, 2013; De Soysa & Jütting, 2006). However, our ability to design robust adaptation strategies remains stifled by a limited understanding of how informal institutions contribute to local adaptation. Agrawal noted that, "there are potentially significant gains to be made by identifying ways of encouraging informal processes through formal initiatives to facilitate adaptation and greater adaptive capacity" (Agrawal, 2010, p. 190). For example, policies focused on strengthening informal institutions can become self-sustaining with minimal need for continued external initiatives or aid (Amaru & Chhetri, 2013). Additionally, the effectiveness of formal rules is often dependent on informal institutions (De Soysa & Jütting, 2006). In an ideal case, the goals of formal institutions are complementary to those of informal institutions, increasing the efficiency, effectiveness, and legitimacy of governance systems (Helmke & Levitsky, 2004; Meek, 2013; Pahl-Wostl, 2009).

The context for this study is the Alaska Native Village of Wainwright, located on Alaska's North Slope. Similar to other Arctic communities, Wainwright is already experiencing the impacts of climate change with regional temperatures warming at a rate that is two to three times faster than the global average (Allen *et al.*, 2018). However, while this study focused on climate change as the primary stimulus for adaptation, it broadly explored situations related to all aspects of social-environmental change. Adaptation actions rarely focus on climate risks and opportunities alone, but are instead undertaken with other goals in mind, such as economic gain, or food security (Noble *et al.*, 2014; Smit & Wandel, 2006). With

Wainwright as a case study, this research explored four main queries; 1) What informal institutions have bearing on adaptation to environmental change and adaptive capacity in Wainwright? 2) How do different informal institutions relate to each other and to different aspects of local adaptation? 3) What changes in informal institutions have occurred over time and what are the potential implications of these changes for local adaptive capacity and future adaptation to change?, and 4) how can the relationship between informal institutions and local adaptation be leveraged in targeted formal initiatives? The Adaptation Institutional Analysis (AIA) Framework was developed as an analytical tool to help map these relationships.

3.2 **Background and theory**

3.2.1 Institutions defined

The concept of institutions holds different meanings across disciplines (Ostrom, 1986; Prell *et al.*, 2010). Using the convention advanced by political economist Elinor Ostrom and commonly used in the field of natural resource management, institutions are defined here as widely understood rules, norms, or strategies that guide and constrain human behavior and action (Crawford & Ostrom, 1995; Prell *et al.*, 2010). Institutions are classified as formal or informal, based on the nature of their development, codification, communication, and enforcement (Pahl-Wostl, 2009). Formal institutions include laws, regulations, standards and other codified measures that are linked to official channels of government and can be enforced legally (ibid.). Informal institutions are socially shared rules such as social or cultural norms that are created, communicated, and enforced outside of officially sanctioned channels (De Soysa & Jütting, 2006; Pahl-Wostl, 2009). Institutions are not organizations, but they are the basis of organizational structure and operations, involving groups of individuals with clearly defined roles, united by a shared purpose, and guided by a common set of rules and procedures (Pahl-Wostl, 2009; Prell *et al.*,

2010). As such, organizations can be viewed as "institutional arrangements" or proxies that, like institutions, can be formally or informally constructed (Polski & Ostrom, 1999, p. 4).

3.2.2 Wainwright Place-Based Classification of Adaptation

To understand the pathways through which informal institutions locally influence adaptation, it is beneficial to characterize the adaptation response options and elements of adaptive capacity available in a given context. *Adaptation responses* are flows with time specific inputs or outcomes, such as collective action taken to raise money for a community member in need (Berman *et al.*, 2017). They are distinct from *elements of adaptive capacity* (stocks/assets), which include social, physical, and economic characteristics that determine the range of available adaptation actions and their potential effectiveness (ibid.). In the study *Place-based Classification of Adaptation*, Curry *et al.* develop a classification scheme for adaptation response options and elements of adaptive capacity specific to the Village of Wainwright (Table 3.1, also see Chapter 2 of this dissertation). The purpose of categorizing aspects of adaptation in this way is to organize potentially innumerable factors into a manageable set of units, supporting adaptation planning and analysis initiatives in both academic and policy settings (Agrawal, 2010).

Table 3.1: Place-based Classification of Adaptation – Wainwright, AK

Adaptation Categories		Description
Adaptation response options	1. Mobility	Physically moving through areas based on availability of resources. Also includes the timing and speed of movement.
	2. Storage	Reduces risk over time by balancing periods of abundance with periods of scarcity.
	3. Diversification	As an adaptation practice, diversification can be applied in many different ways. It involves using alternative assets, resources, or skills to address risk and opportunity.
	4. Communal Pooling	Members of a group working together with the objective of pooling their resources (e.g. food, hunting equipment, environmental knowledge, labor, income) to address risk or opportunity.
	5. Market exchange	Sale or trade of goods and services with local or outside markets. Also a general category for activities related to participation in the cash economy including wage labor, and purchasing goods.
Elements of adaptive capacity	6. Infrastructure & Technology	Infrastructure improvement and technology that contribute to local adaptive capacity.
	7. Research/ Knowledge/ Observation	Available knowledge that is considered meaningful to members of a community. Includes local observations, indigenous knowledge, Western science, or research into new technologies and strategies for adaptation.
	8. Educational/ Behavioral	Sharing knowledge through training, education (formal and informal), or information exchange with the goal of guiding or changing behavior (Feenstra *et al.*, 1998).
	9. Institutional	Formal organizations, rules, and regulations of any scale (local, regional, state) that impact adaptive capacity (Noble *et al.*, 2014).

3.2.3 Adaptation Institutional Analysis Framework

The Adaptation Institutional Analysis (AIA) Framework (Figure 3.1) presents a framework for analysing the interactions between informal institutions and adaptation, which in turn influence local decision-making and adaptation outcomes. It advances Elinor Ostrom's Institutional Analysis and Development (IAD) Framework and is also informed by a complementary framework put forth by De Soysa and Jütting of the Organization for Economic Cooperation and Development (OECD). The IAD Framework is widely applied by social scientists in empirical and theoretical analyses to understand how institutions affect the incentives confronting individuals and their resultant behaviour (Grossman, 2018; Ostrom, 2005). The

OECD Framework provides a more direct focus on informal institutions and their effect on development outcomes (De Soysa & Jütting, 2006; Ostrom, 2005). The *Action Arena* is the focal point of Ostrom's IAD Framework. An *Action Situation* occurs when two or more *Participants* are faced with a set of potential responses with resulting *Outcomes* (Ostrom, 2005). Costs, benefits, time constraints, and other relevant factors are the *Evaluative Criteria* for predicting the outcomes of an action situation. The *Interactions* within the action arena are determined by theory and set the terms for which criteria matter most (Grossman, 2018). While the IAD Framework can be applied in a broad range of action situations, the AIA Framework focuses exclusively on adaptation. As such, the IAD Framework is reflected in the right side of the AIA Framework in Figure 3.1 as the *Adaptation Arena.*

Participants represented in the IAD Framework are assumed to be rational decision-makers. *Rational Choice Theory* makes two key assumptions; 1) individuals are driven to make the most efficient decision they can and 2) individual preferences are aligned with collective decisions such that everybody demands the same action towards a common optimal outcome (Ostrom, 2005; Rayner *et al.*, 2005). However, by focusing on the individual, rational choice theory does not capture the nuances of collective decision-making where norms are socially constructed and bound up with collective meaning and identity (Rayner *et al.*, 2005). In contrast, sociological studies using *neoinstitutionalist* thinking show that rationality is constituted differently across cultures (DiMaggio, 1998). If we believe norms are socially constructed and not self-evident, then understanding the role that informal institutions play as part of the "incentive framework" for human action is key to understanding how desirable policy goals can be achieved (De Soysa & Jütting, 2006, p. 5). The OECD Framework offers a way to engage these issues.

The OECD Framework, unlike the IAD Framework, distinguishes between formal and informal institutions and elaborates on *Institutional Outcomes* as the intermediary connection between exogenous variables and the action arena. In the AIA Framework, this intermediary connection is the *Portfolio of Institutionally-Influenced Adaptation Categories,* which is derived from the Wainwright Place-based Classification of Adaptation (see Chapter 2 of this dissertation). However, these categories are not

universal and would likely change if applied to a different study area. Elements of adaptive capacity are categorized as both exogenous variables and institutionally-influenced adaptation categories. *Adaptation response options* are the variety of actions available to *participants* facing a particular *adaptation situation.*

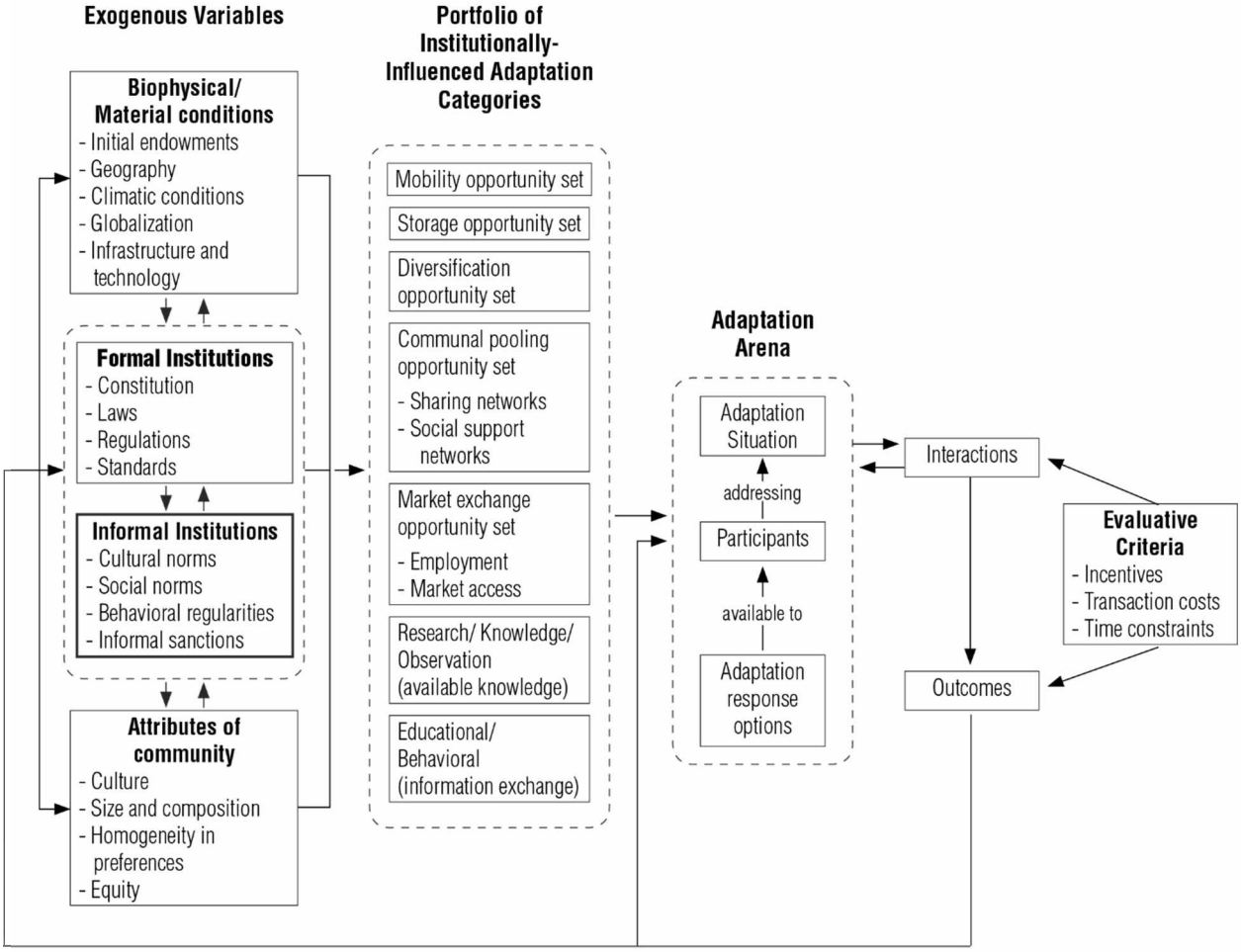

Figure 3.1: Adaptation Institutional Analysis Framework. Adapted from (Chapter 2 of this dissertation), (De Soysa & Jütting, 2006), and (Ostrom, 2005)

The structure of the AIA Framework helps draw a picture of how institutional characteristics influence adaptation and, in turn, shape adaptation outcomes. While informal institutions and their relationship to adaptation are the focus of this paper, they are situated in the Framework amongst other exogenous variables including Biophysical/ Material Conditions and Attributes of Community to demonstrate that they are one subset of potentially many factors that contribute to adaptation (De Soysa & Jütting, 2006).

3.2.4 Distinguishing between norms, values, and culture

The terms norms, values, and culture are conceptually nebulous and often overlapping. Therefore, it is worth spending time here to clarify their meaning in relation to informal institutions for the purposes of this study. *Norms* are guidelines for action that are derived from some combination of three distinct elements; behavioural regularities, sanctions (a system of rewards and punishments), and oughtness (Hechter & Opp, 2001). In the proposed AIA Framework, adaptation outcomes feedback to exogenous variables and, through repetition, can become behavioural regularities when present behaviour is determined in part by past decisions (ibid.) (see Figure 3.1). A downside of this path dependence is that dominant actions or technologies may persist despite having inferior performance, which can lead to non-optimal outcomes (Ng *et al.*, 2018; Pahl-Wostl, 2009). Behavioural regularities may be associated with positive or negative sanctions that are enacted according to social agreement about what ought (or ought not) occur (Epstein, 1968).

Oughtness is defined as shared expectations by members of a group (Hechter & Opp, 2001). It is associated with two attitudes toward norms; acceptance and internalization. Norms can be simply accepted as rules to be followed or they can be internalized as part of a belief system (Hechter & Opp, 2001). *Values* are norms that have been internalized. Values, beliefs, and attitudes are all items of *culture*, which affect the emergence of norms (ibid.). However, not all norms come from deep historical sources as the word culture suggests. Norms can change or emerge rapidly as dictated by the need to solve new social dilemmas (Helmke & Levitsky, 2004). The historical origin of norms and their speed of change are factors that distinguish cultural norms (slow moving) from social norms (fast moving) as defined in this study. Furthermore, values here are synonymous with cultural norms.

3.2.5 Informal institutions in traditional communities

Informal institutions often have greater importance in small Indigenous communities where formal institutions are less developed, and the enforcement mechanisms for formal law and state power are relatively weak (Bardhan, 2000). There is substantial scholarship theorizing how norms emerge and change over time. (DiMaggio, 1998; Hall & Taylor, 1996; Hechter & Borland, 2005; Hechter & Opp, 2001; Opp, 2001; Ostrom, 2005; Platteau, 2006). Some scholars believe there is a trade-off between increasing participation in market-based activities and the local 'moral economy' built upon norms governing altruistic behaviour in traditional societies (Ensminger, 1992; Scott, 2008). The transition from a subsistence to a mixed economy may lead to a reduced capacity to absorb shocks if traditional support networks in a society are lost and not adequately replaced by formal support systems (Burton *et al.*, 1993; Swift, 1989). Native communities on Alaska's North Slope are mixed subsistence-cash economies in which both subsistence and income generating activities are essential for survival and well-being (G. Knapp & Morehouse, 1991; NSB, 2015).

3.3 **Study area**

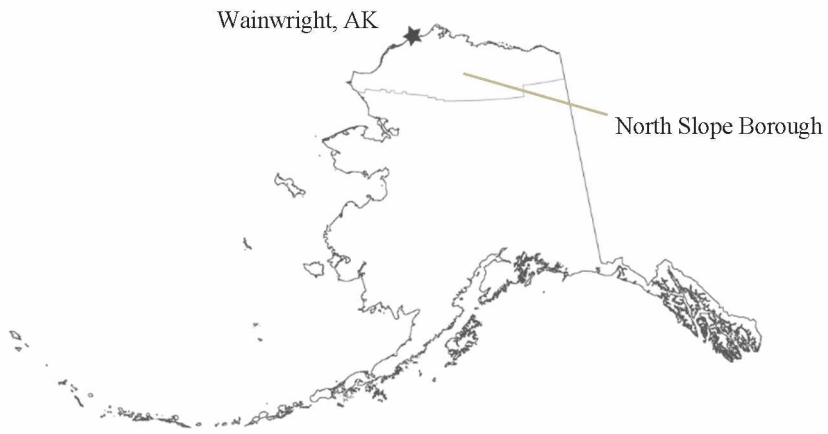

Figure 3.2: Native Village of Wainwright in the Alaska North Slope Borough

This research was conducted in collaboration with the Native Village of Wainwright (traditionally Ulġuniq), an Alaska Iñupiat community located on the state's northwestern coast approximately 120 kilometres (75 miles) by air southwest of Utqiagvik (formerly Barrow, Alaska). With an estimated population of 560, Wainwright is the third largest village in the North Slope Borough (Department of Labor, 2018). Approximately ninety percent of Wainwright residents are Iñupiat (NSB, 2015) descended from the Kuugmiut, people of the Kuuk River, and the Utuqqaġmiut of the Utukok River (Ivie & Schneider, 1988; Wainwright, 2016).

Wainwright has undergone significant transformation over the last 115 years. The development of oil resources at Prudhoe Bay and the subsequent 1971 establishment of the North Slope Borough (NSB) with its ability to tax oil industry facilities, brought an influx of funds to the region (C. N. Knapp *et al.*, 2014). Through its Borough-wide Capital Improvement Program (CIP), the NSB invested tens of millions annually in schools, community halls, water and sanitation facilities, public health programs, and other public services (ibid.). Wainwright today is a modern community. Even so, traditional values remain central to the local way of life (Wainwright, 2016).

Like many northern communities, Wainwright is already experiencing the effects of climate change. The climate is becoming warmer with an observed increase in average annual temperature of 2.5°C (4.6°F) over historical averages (SNAP, 2019). This warming has resulted in decreases in snow and ice, with delayed fall accumulation and early springtime melt (AMAP, 2017). These environmental changes affect conditions for travel and access to subsistence resources. Residents are also observing a shift in animal migratory patterns, eroding shorelines, thawing permafrost, and a number of other environmental changes (personal communication, 2015). The task of responding to environmental uncertainty is further nuanced by varied economic challenges and opportunities including globalization, the prospects of arctic shipping, tourism, and resource extraction (Flato, 2017). The Iñupiat have tremendous resilience, as exemplified by their long history in the Alaskan Arctic (Minc & Smith, 1989; Spencer, 1959). However, communities still draw on support and collaboration from outside resources to fund local initiatives, provide

information, and enact policies that strengthen local adaptive capacity (Johnson, 2011; Swaffield & Primdahl, 2006).

3.3.1 Inupiaqatigiiġñiq: North Slope Cultural Norms

Inupiaqatigiiġñiq is the traditional Iñupiaq value system for the North Slope region. The North Slope Borough School District has developed curricula based on these core values for grades kindergarten through 12 as part of an initiative to integrate Iñupiaq culture into schools and classrooms (North Slope Borough School District, 2008). The value descriptions in Table 3.2 are derived from this curriculum, with additional details provided by local advisors, and interview participants (see Methods below). Additionally, Sean Asiqluq Topkok's dissertation – *Iñupiat Ilitqusiat: Inner Views of Our Iñupiaq Values* (2015) – is a thorough exploration of the Iñupiaq value system of the Northwest Arctic region. Topkok is an assistant professor in University of Alaska Fairbanks, School of Education. His work provides useful insights for a study of North Slope values given the value categories in the Inupiaqatigiiġñiq and the Iñupiat Ilitqusiat substantially overlap (NSB, 2015). The Inupiaqatigiiġñiq is leveraged within this study to establish baseline categories for Wainwright cultural norms (a subset of informal institutions in the AIA Framework).

Table 3.2: Inupiaqatigiigniq (Illisagvik College North Slope Borough in Topkok, 2015) (North Slope Borough School District, 2008)

Values	Description
Respect the following/ *Qiksiksrautiqaġniq*	Elders/ Utuqqanaanun: Our Elders model our traditions and ways of being. They are a light of hope to younger generations. Respect for the knowledge and guidance of Elders (NSB, 2015). Being taught to always help and provide for Elders. others/ *Allanun*: May we treat each other as our Elders have taught us. Includes honoring others' opinions, listening, treating people well, and respecting others' property. nature/ Iñuuniaġvigmun: Our creator gave us the gift of our surroundings. Those before us placed ultimate importance on respecting magnificent gift for their future generations. Wasting nothing, working to ensure the continued health of the environment, acknowledging the limited power of humans in comparison to 'mother nature'.
Family Kinship and Roles/ *Ilagiigñiq*	Kinship: As Inupiaq people we believe in knowing who we are and how we are related to each other. Our families bind us together. Family roles: In traditional Iñupiaq society, many jobs were divided among family members making final outcomes a cooperative effort (North Slope Borough School District, 2008).
Sharing/ Aviktuaqatigiigñiq	It's amazing how sharing works. Your acts of giving always come back. Sharing food and resources with those in need.
Knowledge of language/ *Iñupiuraallaniq*	With our language we have an identity. It helps us to find out who we are in our mind and in our heart.
Cooperation/ Paammaaġigñiq	Together we have an awesome power to accomplish anything. Pooling resources or working together to accomplish a common goal. In some cases it would be impossible for one person to complete the activity on their own (e.g. whaling). In other cases, while it is possible for one person to accomplish a task on their own, there are distinct advantages to working in a group (e.g. caribou hunting) (NSBSD, 2008).
Humor/ Quviaŋġuniq	Indeed, laughter is the best medicine. Focusing on good things during hard times, and finding humor in challenging situations.

Values	Description
Hunting traditions/ *Aŋuniallaniq*	Reverence for the land, sea, and animals is the foundation of our hunting traditions. Hunting success depends on skill, perseverance, foresight, imagination, cooperation, safety, environmental knowledge, and respect for nature. There is a necessity to follow Iñupiaq protocols and beliefs when it comes to hunter success (Topkok, 2015).
Compassion/ Nagliktuutiqaġniq	Though the environment is harsh and cold, our ancestors learned to live with warmth, kindness, caring, and compassion. Being helpful to one another without expecting anything in return. Continuing the tradition of helping each other.
Humility/ Qiñuiññiq	Our hearts command we act in goodness. Expect no reward in return. This is part of our cultural fiber. Sharing with others teaches one to be humble (Topkok, 2015).
Avoidance of Conflict/ *Paaqłaktuataiññiq*	The Iñupiaq way is to think positive, act positive, speak positive, and live positive. Being non-confrontational and not escalating disputes. Allows a person to recognize his/her role in the family and community, and to put aside differences to help each other (Topkok, 2015).
Spirituality Ukpiqqutiqaġniq	We know the power of prayer. We are a spiritual people. Integration of spiritual elements within the belief system. Examples include Christian faith, belief in God's ability to intervene, prayer, the power and agency of nature, and awareness possessed by animals.

3.4 **Methods**

This project and its methodology are the outcome of an iterative process developed and conducted in partnership with the Wainwright Traditional Council and with guidance from a project steering committee comprising three local leaders. Interviews (15) were conducted with 17 long-term residents from the Village of Wainwright. Selection criteria for interview participants included community members that (1) were age 40 or older, (2) had resided in Wainwright the majority of their lives, and (3) had significant experience outdoors in the Wainwright Traditional Use Area. Local Elders (10) were the primary target group given their ability to provide rich, first-hand information, covering a long time scale. An Elder is distinguished from an elderly person based on their recognized leadership in the community, including

leading by example and sharing knowledge (Topkok, 2015). Middle-aged community members (7) identified as having substantial knowledge of the outdoors were also interviewed. Initially, interview participants were recommended by the project steering committee. Additional participants were identified based on suggestions from the initial participants, a process called snowball sampling (Denzin & Lincoln, 2011).

3.4.1 Data collection

Semi-structured, in-depth interviews (Denzin & Lincoln, 2011) focused on each participant's observations of change throughout their lifetime as well as family and community scale adaptations in response to unexpected events, environmental changes, economic development, and other factors. Interview questions were reviewed for appropriateness by project steering committee members and the draft interview protocol was pilot-tested prior to being finalized. Researchers provided an overview of the project and acquired written consent from each participant before starting each interview. Native Iñupiaq speakers were given the option to conduct their interview in Iñupiaq with the assistance of a translator. Five participants chose this option. Out of the 17 participants, eight were female and nine were male. Two interviews were multi-person, both comprising husband and wife couples that requested a joint interview. Researchers ceased conducting interviews after saturation was reached, where the collection of additional data produced no new insights on the issues being investigated (Glaser *et al.*, 1968).

3.4.2 Data analysis

The interviews were transcribed verbatim and then coded and analysed using QSR International's NVivo 12 qualitative data analysis software. During coding, segments of interview text are matched with relevant categories (codes) derived from major research themes (Bazeley, 2013). The coding process followed the directed content analysis approach where initial coding was based on existing theory and relevant research findings (Hsieh & Shannon, 2005). In this case, coding for adaptation was taken from the

Wainwright Place-Based Classification. For a detailed description of the methodology used, see Chapter 2 in this dissertation. Coding for informal institutions was derived from the Inupiaqatigiigñiq with additional categories sourced from the Iñupiat Ilitqusiat (e.g. *domestic skills, hard work, love for children,* and *responsibility to uphold Iñupiaq culture* [*responsibility to tribe*]). In the process of developing the informal institutions coding, emergent codes (additional codes that did not fit into the initial categories) were incorporated after a preliminary round of analysis. These included *environmental knowledge* and *traditional food*, which warranted separate categories based on the large quantity of interview segments assigned to them. Additionally, several codes were consolidated as sub-categories under major headings. *Humor, avoidance of conflict, humility,* and the emergent code *fortitude* were consolidated into *mental attitude*. Furthermore, *knowledge of language, family and kinship,* and the emergent code *traditions and history* were consolidated under the heading *cultural knowledge*. The final informal institutions coding included 15 categories; *compassion, cooperation, cultural knowledge, domestic skills, environmental knowledge, family roles, hard work, hunting traditions, love for children, mental attitude, respect, responsibility to uphold Iñupiaq culture, sharing, spirituality,* and *connection to subsistence and traditional food*. The interviews were coded solely by the lead author. To limit the potential for bias, the final coding and preliminary findings were reviewed by local advisors in Wainwright. A detailed explanation of each of the coding categories is available in Appendix A.

The NVivo Matrix Coding function was employed to analyse the intersections between the interview segments assigned to the finalized informal institutions coding and to the Wainwright Place-based Classification of Adaptation. The results of the matrix analysis are described below.

3.5 Results

The informal institutions referenced by interview participants in association with the most adaptation categories were *hunting traditions, responsibility to uphold Iñupiaq culture, family roles,* and *environmental knowledge*.

Table 3.3: Distribution of informal institutions across combined adaptation categories.

'Number of interviews referenced' shows the number of interviews in which each informal institution was referenced in relation to all adaptation categories. The total displayed is out of a possible 135, which would occur if all interview participants (15) co-referenced a specific informal institution with all nine adaptation categories (one interview may be counted multiple times depending on the number of adaptation categories they associated with a particular informal institution). The number of adaptation categories associated shows the number of adaptation categories represented within the count of interviews from the previous column.

Informal Institution	Number of interviews referenced (out of 135)	Number of adaptation categories associated (out of 9)
Compassion	19	6
Cooperation	24	7
Cultural knowledge	16	6
Domestic skills	19	8
Environmental knowledge	**40**	**9**
Family roles	**40**	**9**
Hard work	21	8
Hunting traditions	**68**	**9**
Love for children	12	5
Mental attitude	24	9
Respect	27	8
Responsibility to uphold	**42**	**8**
Sharing	26	7
Spirituality	0	0
Traditional food	10	3

3.5.1 Notable informal institution-adaptation associations

While Table 3.3 summarizes the involvement of informal institutions across all adaptation categories, Table 3.4 highlights the most widely co-referenced informal institution and adaptation categories one-on-one. Associations made by at least seven interviewees (representing just over half of the informal institution categories) are considered widely co-referenced.

Table 3.4: Widely co-referenced informal institutions and adaptation categories. Displays the number of interviews in which each informal institution was co-referenced with each adaptation category.

	Compassion	Cooperation	Environmental knowledge	Family roles	Hunting traditions	Respect	Responsibility to uphold	Sharing
Communal pooling	10	9	4	7	13	8	13	13
Diversification	1	2	3	7	9	2	2	2
Educational and behavioural	2	2	5	6	7	5	7	3
Institutional	0	2	3	1	4	2	6	0
Market exchange	0	0	1	5	8	2	3	1
Mobility	2	3	7	5	12	1	5	4
Research and observation	0	5	11	4	9	5	5	0

A selection of notable associations between informal institutions and adaptation categories is highlighted here:

Informal institutions and communal pooling – Of the eight most endorsed informal institutions, seven were highly associated with the adaptation response communal pooling. Interview participants mentioned communal pooling most often as a response to past adaptation situations caused by food shortage. Other situations and responses associated with communal pooling included working together to harvest resources, pooling money to help people in need, transferring international whaling quotas to another community in a bad whaling year, and the protest of unfair hunting regulations. In response to famine in

the 1940s, communal pooling occurred via intra- and inter- community networks as described by one participant:

> When the famine in early 40s when they had WWII, the famine started out from there. Hardly any caribou, hardly any seal. Not much animals were around, they're hard to find… Most of the hunters get seals. And they have to rush home in order to let people have food. The hunters don't get the animals for themselves but they spread it out to the whole family… The whole village just about… And we got, ah, flippers from Pribilof Island, seal flippers the send us some… Through the plane and divided through the whole village. (Interview G, 2015)

Another participant noted that the tradition of helping out remains strong in Wainwright:

> To come together, you know to help one another out, which is still a strong tradition …sometimes we hear on the VHF [radio] that so and so needs some food, and we share even with a bag of, a little sugar or something with all the other families that give a little it's a whole bunch. That's one thing too that has not been lost, to give to the needy people that are less fortunate. (Interview K, 2015)

Hunting traditions and adaptation – *Hunting traditions* were associated with the widest range of adaptation categories. Thirteen interview participants associated *hunting traditions* with communal pooling. Mobility was the second most associated adaptation response at twelve. Adaptation situations that interviewees related to mobility include food shortage, change in seasons, and change in animal migration patterns. In reference to changing seasons and animal migratory patterns, one participant noted:

> Since the climate has changed quite a bit, the hunters naturally they think that, like for instance the spring whales, they've already passed by. So nowadays they start, they always try and start preparing early and then go out early. Or kinda ah, go down there as soon as the waters open… (Interview G, 2015)

Environmental knowledge and research/ knowledge/ observation – Eleven participants spoke of the informal institution *environmental knowledge* in relation to research/ knowledge/ observation, an element of adaptive capacity. Research/ knowledge/ observation was mentioned in reference to accumulated knowledge about the environment, and the skills necessary to be safe outdoors and be a successful hunter. One participant noted:

> … our Elders always taught us to let the first [caribou] through because they're the trail blazers for the rest of the caribou herds that are coming up. The first ones run through the airport up there and, just let 'em cross and we knew that the others would follow. And also, the younger people need to remember, never to meet the caribou head on. Otherwise they're going to change their route instead of following the route they usually take. (Interview B, 2015)

3.5.2 Informal institution associations

Table 3.4 highlights the one-on-one associations between individual institutions and adaptation categories, but there are often several informal institutions that can be connected to the outcome of an individual adaptation situation. The collective influence of institutions on adaptation is demonstrated by the great frequency with which informal institutions are widely referenced in association with one another (Table 3.5). *Hunting traditions* stands out in this respect as it was widely referenced in association with the most other informal institutions (7).

Table 3.5: Informal institution associations; the number of interviews in which each informal institution was referenced with another.

	Compassion	Cooperation	Environmental knowledge	Family roles	Hunting traditions	Respect	Responsibility to uphold	Sharing
Compassion	11	3	8	5	7	0	8	8
Cooperation	3	13	2	7	9	3	5	3
Environmental knowledge	8	2	12	6	9	3	7	4
Family Roles	5	7	6	13	9	3	9	6
Hunting traditions	7	9	9	9	15	9	10	10
Respect	0	3	3	3	9	13	4	0
Responsibility to uphold	8	5	7	9	10	4	14	10
Sharing	8	3	4	6	10	0	10	14

(Note: The number of times an informal institution is cross-referenced with itself represents the total number of interviews in which that institution was referenced overall.)

3.5.3 AIA Framework Analysis:

The AIA Framework demonstrates how several informal institutions and adaptation responses can be concurrently engaged by participants in response to an adaptation situation. Figure 3.3 looks at the role of informal institutions in household strategies for balancing the regular occurrence of overlapping seasonal abundance of subsistence resources with periods of resource scarcity, a major challenge for Northern communities in the past (Minc & Smith, 1989). While individuals and families could be successful pursuing most resources independently, it was more advantageous to work in groups to obtain the greatest diversity of resources in the most efficient way. As one participant recounted:

> … her mom and dad, my mom and dad, and then our parent's friends, they would go outside and go camping in the summer or spring time. The men would hunt off in the ocean. The women would be gathering eggs or hunting brants or ducks and everybody shared… (Interview B, 2015).

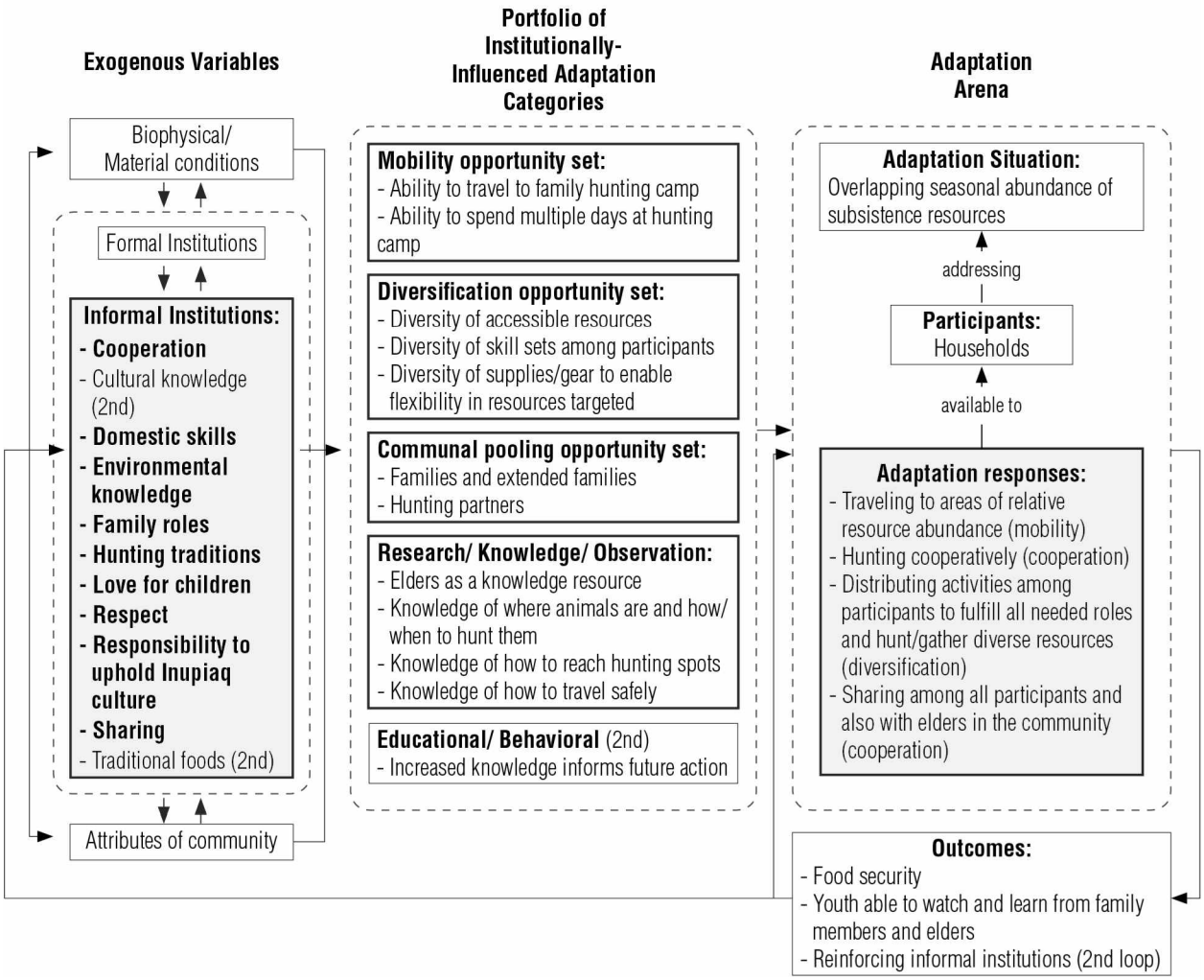

Figure 3.3: AIA Framework analysis of the pathways through which informal institutions exerted influence on local responses to the challenge of overlapping seasonal abundance of subsistence resources.

The informal institutions listed on the left side of Figure 3.3 are the institutions referenced by participants with direct relation to past actions taken in response to overlapping seasonal abundance. The Framework is applied here to analyse an adaptation situation that has already occurred. Therefore, the interactions and evaluative criteria components are not included in the analysis given the prediction of adaptation outcomes is not an objective. The informal institutions and the portfolio of adaptation categories listed and outlined in bold have direct influence on the participant's chosen adaptation responses. Additional factors (cultural knowledge and traditional foods) are then reinforced due to positive feedback from the outcomes of the adaptation situation.

3.5.4 Indications of influence

The eight informal institutions highlighted in Table 3.4 and Table 3.5 were identified based on their repeated association with adaptation categories across interviews. While the prevalence of repeated associations is an indicator of involvement in adaptation, we cannot assume that the institutions identified by this metric are the only ones with influence on an adaptation situation. Additional supporting evidence for the influence of key informal institutions in relation to local adaptation was provided by interview participant responses to the open-ended question: "What values and lessons from the past are most important for people to keep in mind today as they deal with current changes affecting the community?"

The informal institution categories most widely highlighted in participant responses included *hunting traditions, respect, environmental knowledge, and responsibility to uphold.* These categories are consistent with the institutions most widely co-referenced with adaptation. Institutions that were mentioned by interview participants but not previously highlighted based on their association with adaptation include *cultural knowledge, love for children, mental attitude, and traditional foods.* Examples of adaptation situations with which these institutions were linked are provided in Appendix B.

3.5.5 Change in Informal Institutions

Interview participants also discussed their observations of how local values and other informal institutions have changed over time. These changes are summarized below and analysed further in relation to their impact on local adaptive capacity in the discussion that follows.

Two participants characterized whaling traditions as strong, but still undergoing changes. It used to be that the whole community would pitch in, but two respondents noted that today it is primarily the whaling crews (*cooperation)* (Interview K, 2015). A study advisor further noted that, while many people would like to help out, they are unable because they don't have their own means of transportation or the resources to purchase the proper attire to stay warm (Local advisor, 2018).

With the exception of whaling, several respondents noted that hunting is more individual today than it was in the past. Extended families used to hunt together (*cooperation*). Today, people primarily go out with just their immediate families. This negatively impacts a primary pathway for knowledge transfer to younger generations (Interview O, B, C, 2015).

The sources of information from which people draw *environmental knowledge* are more diverse today than in the past. Today, people have access to GPS technology, weather forecasts, and other outside research. Hunters also get fast, up-to-date, information on the location of animals through reports from neighbouring communities via social media (Interview H, L, N, 2015).

One advisor noted that Facebook and social media culture today seems to contradict the traditional value of *humility*. Older generations were taught by their Elders to not brag. Today, people "make a big scene because they want recognition for what they did" (Local advisor, 2018).

Traditional *family roles* and *domestic skills* are reportedly less prominent today. In the past, the whole family contributed to household chores (e.g. hauling ice for water, stockpiling coal) and hunting activities as a necessity for survival. Also, people sewed their own clothing and made their own gear, which were high quality, but time consuming to make. Today, modern amenities like indoor plumbing, and access to outside food and supplies, have made life easier (Interview B, 2015).

Again, whaling is held as an exception to the decline of traditional *family roles* and *domestic* skills. One advisor commented that, in whaling families, tasks like getting whaling gear ready (e.g. fixing snow machines, working on sleds), cleaning out cellars, and shuttling supplies to/from camp are considered "men's work". It is the women's responsibility to prepare the food. This involves having knowledge of the different ways of preparing the heart, kidneys, meat, muktuk [whale blubber], and intestine. Great care is taken to prepare clean, high quality food (Local advisor, 2018).

Some participants perceive a change in parenting styles. In the past, the raising of children was more a communal activity (*responsibility to uphold / cooperation)*. Today, many parents are less open to having

their child scolded or told what to do by others (Interview B, C, 2015; Local advisor, 2018). Similarly, the way that people give constructive criticism is perceived to have changed. As one advisor observed, "It used to be done with more *humor* than it is today" (Local advisor, 2018).

Two respondents noted that there are very few Iñupiaq speakers today (*knowledge of language*). Many parents do not speak the language themselves and cannot pass it on to their children (Interview A, M, 2015).

3.6 **Discussion**

Interview data were analysed according to themes derived from Iñupiaq social and cultural norms (North Slope Borough School District, 2008) and the local context of adaptation in Wainwright (Chapter 2 of this dissertation). Nearly all informal institution categories were found to be linked to adaptation and elements of adaptive capacity. The results of the contextual analysis are discussed below according to the study's four primary focal points; 1) the distribution of informal institutions in facilitating local adaptation, 2) how different informal institutions relate to each other and to different adaptation categories, 3) what these findings suggest about how changes in informal institutions might impact future adaptive capacity, and 4) how an understanding of the relationship between informal institutions and local adaptation might be leveraged in targeted formal initiatives.

3.6.1 Distribution of informal institutions across local adaptation categories:

Four informal institutions stood out as the most widely referenced in association with all adaptation categories (see Table 3.3). Reported in order of the number of interviews in which they were referenced, these were *hunting traditions* (68), *responsibility to uphold Iñupiaq culture* (42), *environmental knowledge* (40), and *family roles* (40). The next most widely referenced categories of institutions included

respect (27), *sharing* (26), *cooperation* (24), *and mental attitude* (24). The prominence of these categories are an indicator of potentially significant influence on adaptation actions.

Four insights were drawn from this analysis. 1) Informal institutions that stand out in the overall distribution of informal institutions across all adaptation categories also exhibit strong associations (referenced in 7 or greater interviews) with individual adaptation categories (see Table 3.4). 2) The influence of some informal institutions appears to be more dispersed (e.g. spread widely over many adaptation categories rather than concentrated in a few). The second most prominently referenced categories of institutions mentioned above share this characteristic. 3) The only institution that was not directly associated with any adaptation categories was *spirituality*. However, while the data revealed no direct relationship between *spirituality* and local adaptation, it may have indirect influence through its association with the informal institution categories *mental attitude,* and *respect* (Table 3.5). *Spirituality* was referenced in association with these categories in three of the total six interviews in which it was referenced. 4) Informal institutions appear to be only weakly associated (co-referenced by less than five participants) with the adaptations *storage* (14), and *infrastructure and technology* (31), which are largely associated with biophysical/material conditions (e.g. permafrost stability, technological innovation) and formal institutions (e.g. public works projects) (see Chapter 2 of this dissertation).

3.6.2 Relationship between informal institutions and adaptation:

Table 3.4 highlights the informal institutions and adaptation categories that were referenced together by the most interview participants. These pairs, based on their prevalence in interview accounts, are inferred to be the most commonly involved in adaptation and are thus considered ideal targets for concerted efforts to support informal institutions for the purpose of adaptation. The following three conclusions were drawn from this analysis:

First, the adaptation category most prominently related to informal institutions was communal pooling, which was associated with seven of the eight most widely co-referenced institutions. This was largely due

to the prominence of communal pooling as an adaptation response category, which is determined by a few primary factors including the wide range of events and conditions for which communal pooling can be applied, the frequency with which those events and conditions occur, as well as the number of people directly involved (see Sec 2 of this dissertation). For example, communal pooling is associated with a range of activities including sharing food, helping with household chores, raising money for a cause, cooperative hunting practices, and even organizing a unified response to a perceived injustice. Many of the potential applications of communal pooling are part of everyday life and happen frequently (e.g. helping out and cooperative hunting). Furthermore, communal pooling by definition directly involves numerous people (ibid.).

Additionally, communal pooling is unique in comparison to other adaptation categories given formal institutions and short-term changes in biophysical/material conditions exert relatively little influence on it. Mobility, for example, is an equally prominent adaptation response that is widely co-referenced with only two informal institutions (*environmental knowledge,* and *hunting traditions*). While it appears to be only minimally influenced by informal institutions, mobility is highly dependent on the biophysical/ material conditions in Wainwright including infrastructure and technology, weather, and the price of fuel.

A **second** observation drawn from the analysis is that *hunting traditions* stood out as the most prominent informal institution. It was referenced widely across all adaptation categories and was also highly related to other informal institutions (Table 3.5). This finding is consistent with a key message from the Inuit Circumpolar Council's *Alaskan Inuit Food Security Conceptual Framework*. Subsistence resources and the activities associated with the harvest of these resources are the cornerstone of Iñupiaq culture (Inuit Circumpolar Council-Alaska, 2015). These activities provide not only nutritional value, but also define and establish a sense of family and community, and are the avenues through which cultural values and skills are learned (NSB, 2015).

A **third** observation is that accounts shared by interview participants often involved multiple informal institutions (Table 3.5) and there was significant overlap in their association with adaptation categories.

This implies that the influence of informal institutions on adaptation is largely collective rather than individual. The interactions between informal institutions and adaptation categories form a tangled network of relationships, which the AIA Framework can help to elucidate (see Figure 3.3).

3.6.3 Impacts of changing informal institutions on adaptive capacity:

The patterns and pathways of influence revealed in this study provide insight into which local adaptation categories are likely to be impacted by changing informal institutions based on the patterns of association they have exhibited in the past. Knowledge of these associations illustrates the key role informal institutions play in local adaptation. It also provides an understanding of the potential feedbacks associated with changing informal institutions, thus helping to elucidate complex relationships that are not otherwise apparent to actors and decision-makers from outside the community. Interview participants identified changes in several informal institutions observed in their lifetimes including *cooperation, cultural knowledge, environmental knowledge, domestic skills, family roles, and mental attitude* (Section 3.5.5). The potential impacts of declining cooperative practices are described below and in Figure 3.4 as a representative visualization that demonstrates the interconnected nature of informal institutions and adaptation.

Cooperation has a strong association with the adaptation response communal pooling. Therefore, a decline in *cooperation* is likely to negatively impact the potential applications of communal pooling for adaptation, including activities like cooperative hunting, breaking trail, and the hauling and butchering animals. Furthermore, changes in *cooperation* are also likely to impact other informal institution categories that are closely related (*family roles, hunting traditions,* and *responsibility to uphold*). These informal institutions collectively exhibit strong involvement in the adaptation categories communal pooling, research and observation, diversification, educational and behavioural, market exchange, and mobility. Three interview participants observed a decline in the practice of cooperative hunting during the same time frame that the prevalence of the adaptation market exchange was increasing. The threat of

famine in Wainwright today is minimal due to increased market access, which enables the purchase of food and supplies from outside the community. However, declining *cooperation* also impacts a primary pathway for knowledge transfer to younger generations. The ability of young people to gain *environmental knowledge* and *cultural knowledge* is tied to their ability to spend time out on the land, engaging in *hunting traditions*, and learning from their relatives and Elders. If a child's parents and immediate family members do not hunt, they may miss out on gaining important knowledge that is essential for both survival and cultural identity (Interview O, 2015).

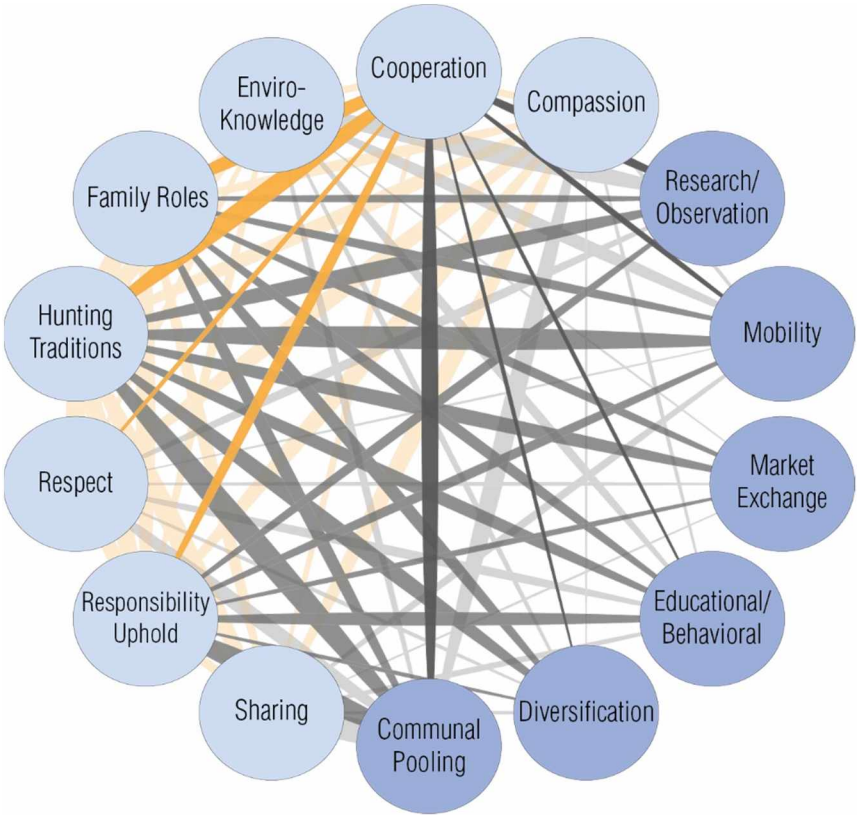

Figure 3.4: Pathways of influence between cooperation, other closely associated informal institutions, and adaptation categories.

Linkages between cooperation and other informal institutions are shown in yellow, and those between informal institutions and adaptation categories are shown in grey. The number of interviews in which each association was endorsed is positively associated with the width of their respective lines.

3.6.4 Implications of findings in leveraging informal institutions to support adaptation

Informal institutions play a role in facilitating both autonomous and planned adaptations. *Autonomous adaptations* are initiatives by individuals and households that occur "naturally" without centrally planned efforts from formal institutions (Smit & Pilifosova, 2001). They include the historically developed adaptation practices and cultural assets that people in the Arctic have developed over millennia like comprehensive knowledge of the local environment, and close-knit social networks built on collaboration and sharing (Armitage, 2014). Autonomous adaptations and the informal institutions that support them may substitute for ineffective formal institutions or insufficient outside funding resources (Amaru & Chhetri, 2013). However, the continued success of these practices depends on the presence of functioning informal institutions. Towards this end, the findings of this study identify the informal institutions that interview participants widely associated with past autonomous adaptations. *Hunting traditions* stood out as a key category with influence on nearly every dimension of adaptation. While many hunting traditions have changed, the practice of whaling was identified as one that is still going strong and contributing to the continued preservation of other informal institutions (e.g. *cooperation, environmental knowledge, family roles, respect, responsibility to uphold, sharing*). For this reason, activities with the potential to undermine whaling practices, such as offshore oil drilling or increased shipping, might also adversely impact local adaptive capacity. Consequently, such activities warrant intense scrutiny from both local and outside actors. Beyond highlighting important institution-adaptation relationships, this research also provides evidence that justifies the support of varied social initiatives given their applications reach beyond altruism by additionally supporting proven strategies for adaptation. Access to proper gear and transportation were identified by local advisors as barriers to *cooperation* in relation to communal activities like serving on a whaling crew. The strong relationship identified between *cooperation* and adaptation helps justify funding initiatives that support access to basic gear given their potential to positively impact adaptive capacity.

Planned adaptations are those enacted or influenced by governments or collectives for the purpose of reducing vulnerability through efforts that diminish risk or increase adaptive capacity (UNFCCC, 1992). Planned adaptation policies are more likely to achieve success if they are reflective of local norms (Meek, 2013). Knowledge of the relationship between local informal institutions and adaptation in Wainwright can guide the design of formal institutions and initiatives that complement rather than undermine existing dynamics. To address the challenge of passing on *environmental knowledge*, *cultural knowledge*, and *hunting traditions* to the younger generation, one interview participant identified a need to fund school or community-run programs to provide learning opportunities for students whose families do not have the resources to take them hunting (*institutional, educational/behavioural*) (Interview O, 2015). Another example highlights the informal institution *environmental knowledge*, which is closely associated with the element of adaptive capacity research/knowledge/observation. Local people are increasingly obtaining information from outside sources (e.g. weather reports, remote sensing observations) and sharing their own observations via online social media platforms. Initiatives that increase the ability or incentive to communicate knowledge, observations, and innovations between communities can be implemented through the efforts of regional organizations or outside institutions (Amaru & Chhetri, 2013). An example of one such initiative is the Local Environmental Observer (LEO) Network maintained by the Center for Climate and Health at the Alaska Native Tribal Health Consortium since 2012. The LEO Network database is an online platform which functions as a tool for the tribal health system, local observers, and topic experts to share information about climate and other drivers of environmental change (ANTHC, 2015). This initiative concurrently addresses three elements of adaptive capacity; infrastructure & technology, research/knowledge/observation, and institutional.

In Appendix C, Table 3.7 summarizes the informal institutions most closely associated with autonomous adaptations. Table 3.8 summarizes the informal institutions most closely associated with potential planned adaptations.

3.6.5 Study limits and future research needs

Two limitations of the research methodology employed for this study should be noted. First, the informal institutions highlighted by the contextual analysis are biased by the topics interview participants were willing to discuss. For example, *Spirituality* was the least referenced informal institution and the only one with no identified direct relationship to adaptation. This is not necessarily an indicator of the importance of this category given it is possible that participants did not feel comfortable discussing the topic with a non-local interviewer. Second, the contextual analysis highlights informal institution and adaptation category associations that are made within the same or adjacent segments of transcribed interview narrative. To account for any potentially missed associations, secondary and indirect relationships between informal institutions and adaptation were also analysed (see Appendix C). Additionally, the interview protocol included an open-ended question that inquired which past values and lessons participants considered most important for people to keep in mind to address the challenges of today. Their answers provided additional evidence supporting the primary influence of the relationships identified in the contextual analysis (see Appendix B).

These research findings were validated by local advisors who suggested that future research should involve youth participants. This study targeted seniors and Elders, which are a respected but small subset of the Wainwright population. Their opinions and observations may differ significantly from those of youth who also offer a valuable perspective given they are the next generation that will be confronting the village's ongoing social and environmental changes. Additionally, the influence of informal institutions on adaptation was explored in this research without distinguishing between positive and negative adaptation outcomes. The distinction is important given some informal institutions can be maladaptive or incongruous with formal institutions (De Soysa & Jütting, 2006; Ng *et al.*, 2018). Future research is needed to explore the spectrum between complementary and competing informal institutions and their relationships to what local communities determine to be positive and negative adaptation outcomes (Helmke & Levitsky, 2004; Ng *et al.*, 2018).

3.7 Conclusion

In this paper a contextual analysis approach was used to identify relationships between informal institutions and adaptation in the context of past adaptation responses observed by long-time residents of the Native Village of Wainwright. Several patterns were found in the data. Communal pooling was highlighted as an adaptation response closely associated with multiple informal institutions, and *hunting traditions* stood out as an informal institution closely related to multiple adaptation responses and multiple other informal institutions. Furthermore, the data identified eight primary institution-adaptation relationships in which informal institutions are shown to be a common source of influence in adaptation outcomes. The AIA Framework was developed as an extension of Ostrom's IAD Framework to help explore these findings. The Framework focuses on informal institutions as one of several exogenous variables that set the parameters for action in an adaptation situation. It functions as a tool for analysing the collective influence of multiple informal institutions on a range of potential adaptation options and also the feedback mechanisms through which adaptation outcomes may reinforce or undermine institutions. Through the Framework, the cumulative effects of adaptation outcomes are made visible as institutions and other exogenous variables not initially involved in the adaptation situation are impacted by its outcomes.

There is a disconnect in environmental governance between actors operating at different scales and a clear need to improve understanding of local dynamics in order to design effective and sustainable adaptation strategies at local levels (Chapter 2 of this dissertation) (Balvanera *et al.*, 2017; Cash *et al.*, 2006). Towards this end, the research findings and the proposed AIA Framework function to elucidate the relationships between informal institutions and local adaptation, including the potential impacts of changing informal institutions on adaptive capacity in Wainwright, Alaska. These findings may assist in prioritizing formal initiatives aiming to support elements of adaptive capacity via informal mechanisms. Further, by contributing to an improved understanding of the function and potential of informal

institutions in adaptation processes, this research may benefit adaptation outcomes by helping to align top-down policy goals with local level priorities.

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Appendices

Appendix A

The informal institutions coding was derived from the Inupiaqatigiiginiq with additional categories sourced from the Iñupiat Ilitqusiat (e.g. *domestic skills, hard work, love for children,* and *responsibility to uphold Iñupiaq culture* [*responsibility to tribe*]). Emergent codes, additional codes that did not fit into the initial categories, were incorporated after a preliminary round of analysis. These included *environmental knowledge* and *traditional food*, which warranted separate categories based on the large quantity of interview segments assigned to them. Additionally, several codes were consolidated as sub-categories under major headings. *Humor, avoidance of conflict, humility,* and the emergent code *fortitude* were consolidated into *mental attitude*. Additionally, *knowledge of language, family and kinship,* and the emergent code *traditions and history* were consolidated under the heading *cultural knowledge*. The final informal institutions coding and their descriptions are presented in Table 3.6.

Table 3.6: Informal institutions coding with descriptions

Informal Institutions	Description
Compassion	Being helpful to one another without expecting anything in return. Continuing the tradition of helping each other[1] Warmth, kindness, and caring[2]
Cooperation	At the village scale. Pooling resources or working together to accomplish a common goal. Also includes coordination of activities across villages[3] In some cases such as whale hunting it would be impossible for one person to complete the activity on their own. In other cases such as caribou hunting, while it is possible for one person to hunt on their own, there are distinct advantages to working in a group Communal society with close-knit extended families[3] Cooperation is related to humility, being willing to accept help from others[4]
Cultural knowledge (excluding environmental knowledge)	Knowledge of language: Language as identity. Our language helps us know our minds and our hearts[5] Family and Kinship: Belief in knowing who we are and how we are related to one another. Our families bind us together[5] Knowledge of family tree ensures you will always have a place to stay when visiting other villages[6] Traditions and history: Performing dances, hearing stories[3]
Domestic skills	Taking care of the home (cooking, cleaning, keeping the house warm) Turning raw materials into food, supplies, and gear Children learning by observation and helping out[3]

[1] Wainwright interviews, personal communication, 2015

[2] North Slope Borough School District. (2008). Inupiaq Education: Values Units. Retrieved March 18, 2019, from https://www.nsbsd.org//site/Default.aspx?PageID=2767

[3] Alaska Native Knowledge Network.). Inupiaq Cultural Values. Retrieved May 05, 2015, 2015, from http://ankn.uaf.edu/ANCR/Values/Inupiaq.html

[4] Topkok, Charles Sean Asiqluq. (2015). *Inupiat Ilitqusiat: Inner Views of our Inupiaq Values.* (PhD), University of Alaska Fairbanks.

Informal Institutions	Description
	Closely related to family roles, but distinct. A role is the responsibility to do something, a skill is the ability to do it[6]
Environmental knowledge	Includes basic knowledge of where the animals are, and where they should be at certain times; familiarity with the land and ocean, making keen observations, knowledge of seasonal patterns, knowledge of place names, passing on knowledge to young people, and information from western science[3]
Family roles	Similar to cooperation but at the family scale. Working together to accomplish a common goal. Also, responsibilities and tasks carried out by specific members of a family. One important aspect of having family roles is showing children, so they will have the knowledge when they get older[3] Each family has roles that need to be fulfilled in order to endure[6] In traditional Inupiaq society, many jobs were divided making final outcomes a cooperative effort[4]
Hard work	Necessity to always be moving and working to ensure that the needs of family and community are met. Balancing multiple obligations. Working for what you want and not expecting handout[3] Connection between hard work and respect for nature, domestic skills, and family roles[6]
Hunting traditions	Hunter success depends on skill, perseverance, foresight, imagination, cooperation, safety, and knowledge about the environment (animal habits, weather, etc.)[3] Reverence for the land, sea and animals[4] Self-esteem for the successful harvest of a resource and family and public appreciation in the distribution of the harvest[5] Necessity to follow Inupiaq protocols and beliefs when it comes to hunter success[6]
Love for children	Ensuring the safety and protection of children Giving children the knowledge and skills they need to survive Teaching children about their history and culture Seeing children as the future leaders of the community[3] Involving children in celebrations and meetings even though they may not be active participants because they are part of the "Future Realm"[6]
Mental attitude and behavioral norms	Humor: Focusing on good things during hard times, and finding humor in challenging situations[3]

[5] NSB. (2015). *Economic Profile & Census Report*. North Slope Borough Mayor's Office. Barrow, AK.

Informal Institutions	Description
	Laughter is the best medicine[4] Using humor to handle stressful situations[6] Avoidance of conflict: Being non-confrontational, and not escalating disputes. Belief that people will get what's coming to them in the end[3] The Inupiaq way is to think positive, act positive, speak positive, and live positive[4] Allows a person to recognize his/her role in the family and community, cope with contemporary issues, and put aside differences to help each other[6] Humility: Never boasting[3] Acting on goodness and expecting no reward in return[4] Sharing with others teaches one to be humble[6] Fortitude: Strength in the face of adversity Living day-by-day and not getting too far ahead of yourself
Respect	For each other: Honoring others' opinions, listening, treating people well, never turning ones back on anybody that needs help, respecting other people's property[3] Related to sharing, welcoming visitors with a place to sit and refreshments Working together, everyone makes a contribution even though they have different talents[6] For Elders: Respect for the knowledge and guidance of Elders[7]. Being taught to always help and provide for Elders[3] An Elder is anyone who is considered an Elder by their community. A characteristic that distinguishes Elders from elderly people is their leadership skills, including leading by example and sharing their knowledge with younger generations[6] Our Elders model our traditions and ways of being. They are a light of hope to younger generations. May we treat each other as our Elders have taught us For nature: Wasting nothing, working to ensure the continued health of the environment, acknowledging the limited power of humans in comparison to "mother nature"[3] Ultimate importance of respecting the gift of nature for future generations[4] If nature is treated with disrespect, it may retaliate[6]

Informal Institutions	Description
Responsibility to uphold Iñupiaq culture	Efforts contributing to the strength, wellbeing, and safety of the community. Upholding community values. Includes responsibility to teach younger people[3] 'Tribe' means something different to each person. Can mean family, others in the community, or the people you shared a childhood with in ancestral lands. Tribe can also refer to culture and responsibility to pass down Inupiaq knowledge to children[6]
Sharing	Sharing food and resources with those in need[3] Acts of giving always come back[4] Sharing is also related to knowledge and other metaphysical items like sharing time with Elders and dancing[6]
Spirituality	Integration of spiritual or non-physical elements within the belief system. Examples include Christian faith, belief in God's ability to intervene, prayer, the power and agency of nature "mother nature", awareness possessed by animals "6th sense"[3] Belief in the power of prayer[4] Spirituality is a process an individual experiences to come to terms with the inuk (person). Not to be confused with a group of people who share aspects of the same spirituality[6]
Traditional food (connection to subsistence and traditional foods)	Being able to provide for one's own family and community, cultural connection and health benefits of traditional food[3] Subsistence resources and the activities associated with the harvest of these resources provide the most basic memories and values in an individual's life[7]

Appendix B

Additional supporting evidence for the influence of key informal institutions in relation to local adaptation was provided by interviewee responses to the open-ended question: "What values and lessons from the past are most important for people to keep in mind today as they deal with current changes affecting the community?" Institutions that were mentioned by interviewees but not previously highlighted based on their association with adaptation include *cultural knowledge, love for children, mental attitude, and traditional foods.* Examples of adaptation situations with which these institutions were linked are provided below.

Cultural knowledge: Interviewees talked about the importance of maintaining the Iñupiat language, and continuing traditional practices like being brought up to know who one's relatives are, and to always respect and help each other.

> …parents should always tell their kids who they're related to because it's important. They might have relatives in Point Hope, Kotzebue… I make sure [to say when] my cousins come in that they're related to me through either our parents or through our grandparents or, you know ah, that's how our parents taught us. (O, personal communication, 2015)

> … we can still go ahead and teach them what we used to do, how we used to do it, how we helped each other and I really stress that to the kids to never ignore anybody that needs help. (O, personal communication, 2015)

Love for children: Discussion of important values often focused on concern for the well-being of youth and, as an extension, the community.

> But still, some kids hardly ever go out to go hunting because their parents don't go out hunting because they don't have the boat or the skidoos or, you know. But still, they should concentrate on getting those kids that are less fortunate to try and get 'em involved through the school or community to try and get them involved in hunting or something. (O, personal communication, 2015)

> "Well, I think the community needs to come together. Get the young people involved with what is happening in our village and educate them… You are young and you need to get involved. Don't just be ignored." (B, personal communication, 2015)

Mental attitude: Similar to *cultural knowledge*, topics related to *mental attitude* focused on being brought up to appreciate Iñupiaq behavioural norms.

> My mother always used to tell us not to think or talk badly of other people even if they are different, or poor or have less than you… My mother also told me not to boast or to show off what you have. (M, personal communication, 2015)

Traditional foods: Related to h*unting traditions* and *respect for nature*, interviewees spoke of the importance of traditional foods for local well-being.

> …keep on hunting. We live on that. We depend on our animals. Although we get [outside] food… we can't live without our own animals from here. (E, personal communication, 2015)

Appendix C

Table 3.7 summarizes the informal institutions most closely associated with autonomous adaptations. Table 3.8 summarizes the informal institutions most closely associated with potential planned adaptations. The informal institutions co-referenced with adaptation options and elements of adaptive capacity in seven or more interviews (out of 15) are listed under primary associations. Those referenced in five to six interviews, or identified in primary association with closely related informal institutions are listed as secondary associations.

Table 3.7: Informal institutions associated with autonomous adaptations

Adaptation options	Autonomous adaptation examples	Associated informal institutions	
		Primary	Secondary
Mobility	- Extending hunting range during food shortage - Adjustment from long to short hunting trips due to employment responsibilities - Greater preparedness and urgency due to shorter window of opportunity for hunting walrus	Environmental knowledge Hunting traditions	Compassion Cooperation Family roles Responsibility to uphold Respect Sharing
Storage	- Large quantities of food traditionally stored in ice cellars. Means of moderating periods of resource availability to with periods of scarcity - Freezers have provided a suitable, but not equivalent alternative as many ice cellars fail	Infrequently associated	Infrequently associated
Diversification	- Pursuing alternative livelihoods, like reindeer herding - Adoption of snow machines as an alternative means of transportation to dog teams - Diversification of traditional family roles to allow households to access multiple resources that overlap in timing of availability	Family roles Hunting traditions	Compassion Cooperation Love for children Mental attitude Respect Responsibility to uphold Sharing Traditional foods
Communal Pooling	- Sharing food - Helping Elders with chores - Hunting as a group with family or hunting partners - Pooling money to support those in need	Compassion Cooperation Family roles Hunting traditions Respect Responsibility to uphold Sharing	Cultural knowledge Domestic skills Love for children Mental attitude

Adaptation options	Autonomous adaptation examples	Associated informal institutions	
		Primary	Secondary
Market exchange	- People must work to obtain fuel and other supplies necessary for subsistence - Ability to purchase gear and supplies that used to be handmade	Hunting traditions	Compassion Cooperation Environmental knowledge Family roles Respect Responsibility to uphold Sharing

Table 3.8: Informal institutions associated with opportunities for planned adaptation

Elements of adaptive capacity	Opportunities for planned adaptation	Associated informal institutions	
		Primary	Secondary
Infrastructure & Technology	- Sea wall to protect shoreline from erosion - Houses built on raised platforms to protect from flooding - Access to modern technologies that address local needs	Infrequently associated	Infrequently associated
Research/ Knowledge/ Observation	- Pride and respect earned for having deep knowledge of one's environment - People rely on local and indigenous knowledge as well as information from outside sources, such as weather reports - Platforms that enable communication of environmental observations through social media - Information is important for making informed decisions (e.g. safety during hunting, decisions local leaders make that impact the community)	Environmental knowledge Hunting traditions	Compassion Cooperation Family roles Responsibility to uphold Respect Sharing
Educational/ Behavioral	- Teaching young people cultural norms like always helping Elders - Information exchanged by learning from parents and grandparents	Hunting traditions Responsibility to uphold	Compassion Cooperation Cultural knowledge Environmental knowledge Family roles Love for children Mental attitude Respect Sharing
Institutional	- Regional initiatives (e.g. North Slope Borough Capital Improvement Program) - International representation (e.g. Inuit Circumpolar Council, Alaska Eskimo Whaling Commission) - Regulations can adversely affect adaptive capacity (e.g. conservation measures that restrict ability to hunt non-threatened species)	Infrequently associated	Hard work Responsibility to uphold

4. Images as information: Context-rich images and the communication of place-based information for increased representation in environmental governance[1]

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Abstract

Practitioners widely acknowledge the importance of including local and Indigenous knowledge in environmental research and decision-making. Still, it remains a challenge to achieve this integration in a meaningful way. The formative study reported here was a necessary step toward developing improved methods for communicating local and Indigenous knowledge (including social science of local and Indigenous knowledge) to decision-makers, with a focus on public sector practitioners as audience and visual content as medium. The proposed methodology extends previous research on climate change adaptation in the Alaskan Arctic, and it examines the effect of a reporting approach that introduces two components outside of general conventions in public sector information dissemination; 1) the application of context-rich images to help convey the social and cultural nuances of place-based information, and 2) the presentation of information from Western science and local/Indigenous knowledge systems alongside one another in the same report. Context-rich images – defined here as detailed visuals that address the particularities of specific environments and cultures – are explored given their potential merits in expressing place-based concepts, such as social life and lived experience quickly and concisely when presented in tandem with text. With a focus on practical application, the benefits and limitations of public sector conventions for reporting place-based information to decision-makers are investigated. Insights from both theory and practice informed the research methodology, and the design of a sample report and survey tested with upper-level public sector practitioners who have influence on environmental decision-making. Formative study results indicated significant benefits of using context-rich images in addition to local quotes for reporting information about the lived experience of Northern environmental changes. When presented alongside research from Western science, neither local observations in the form of quotes, nor context-rich images posed negative impacts on the perceived credibility of the report. The formative study revealed the proposed methodology to be particularly beneficial for a target audience of practitioners who may lack expertise in the local context or field of research being reported. Additionally, several potential improvements to the content and design of research materials were identified for the benefit of future studies.

4.1 Introduction

Collaboration, negotiation, and decision-making undertaken in the interest of adaptation to climatic and social change bring together diverse stakeholders from a range of disciplines and cultural backgrounds. On Alaska's North Slope this includes representatives from local tribal communities, regional (North Slope Borough-wide) organizations, state and federal agencies, industry, and academia. While higher government levels play a key role in establishing the institutional capacity (legal, regulatory, policy, and funding initiatives) for adaptation, collaboration and knowledge exchange at the local scale are essential for relevance, feasibility, and broad stakeholder engagement (Trainor *et al.*, 2017). However, given the dominance of technical information in Western decision-making arenas, differentiated sources of information including local and Indigenous knowledge are often underrepresented (Lemos, 2008). This can leave decision-makers with inaccurate or insufficient information, which may lead to biased decisions that ultimately harm North Slope communities.

Scholarship in the sustainability sciences has extensively described the boundaries that exist between different cultural groups. However, the field needs to expand its discussion of the communication-related dimensions which vary depending on the context in which they occur and the groups involved (McGreavy *et al.*, 2013). The formative study presented here pilot-tested a methodology for exploring the effect of a reporting approach intended to address this need within the context of public sector environmental management and decision-support tools. The proposed approach introduces two components that are outside of general conventions in public sector information dissemination; 1) the application of context-rich images to help convey the social and cultural nuances of place-based information, and 2) the integration of information from both Western science and local/Indigenous knowledge systems within the same report. In a similar vein, this research also addresses a need in the social sciences for visual tools that are better aligned with constructivist epistemologies concerned with contextual detail rather than abstracted and generalizable concepts. The project methodology is based on theory from sustainability

science, as well as media communication and visual studies. It is also informed by semi-structured interviews with public sector practitioners, and guidance from the project's local community partners in the Native Village of Wainwright, AK. A survey instrument, context-rich images (including photographs, montage, and Native art commissioned for the project), and a series of sample reports were developed and then tested with upper-level, public sector practitioners. The paper proceeds as follows. Section 4.2 frames the study through the lens of sustainability science and highlights knowledge gaps impacting the management of complex social-environmental systems. Additionally, a summary of key concepts in visual theory makes the case for context-rich visuals as tools to help overcome information biases plaguing transdisciplinary governance efforts. Section 4.3 describes the study area and methodology including parent study data collection, data analysis, and key informant interviews, which collectively shaped the formative study. Section 4.4 summarizes results and discusses key findings including the impact of context rich images and quotes on report credibility, reader comprehension of place-based concepts, and other metrics as perceived by formative study participants. Practical recommendations for reporting techniques in public sector environmental management and for future studies attempting to understand integrated (e.g. multiple knowledge system) and visual reporting approaches are discussed.

4.2 **Theoretical Basis**

4.2.1 Sustainability science and environmental governance:

This research is grounded in the field of sustainability science, a transdisciplinary endeavor that seeks to engage complexity in social-ecological systems (McGreavy *et al.*, 2013). The management of complex social-ecological systems involves consideration of both human and non-human interests, as well as the interaction of these components across time (e.g. short-term, long-term) and spatial (e.g. local, regional, national, international) scales (ibid.). Collaborative efforts that span disciplinary and cultural boundaries are also part of this process, with a potentially broad range of stakeholders (e.g. local communities,

academia, industry, public agencies, and NGOs) contributing to policy development and implementation (McGreavy *et al.*, 2013). An increasing interest in the potential of collaborative rather than top-down policy processes in environmental management is underscored by a shift in discourse from 'government' to 'governance', which encompasses the coordinating and steering activities that enable cooperative efforts (Pahl-Wostl, 2009). While environmental management refers to activities such as monitoring, developing, and implementing measures to achieve or maintain desired environmental conditions, environmental governance takes into account broader social contexts that enable the management of complex systems (Folke *et al.*, 2005; Pahl-Wostl, 2009). This includes the system of organizations and institutions (e.g. rules, laws, regulations, policies, social and cultural norms) involved in governing environmental resources (Chaffin *et al.*, 2014) with a focus on negotiating and decision-making processes undertaken by networks and individuals.

4.2.2 Knowledge gaps in environmental policy and decision-making:

Environmental governance relies on information about the state of the environment and human-environment interactions. Given the tradeoffs inherent to decision-making processes, resource managers require knowledge about individual and social values to adequately understand the likely effects of their decisions on valued outcomes (Dietz *et al.*, 2003). Among information sources generated, shared, and used for decision-making, "formal science" grounded in positivistic methodologies, remains authoritative (Adger *et al.*, 2009; Eden *et al.*, 2006; Lemos, 2008). The post-positivist paradigm reflects most quantitative research today (Gray, 2013). Post-positivism aspires to separate values from scientific questions of fact, and uses purportedly objective methods to study phenomena in an effort to derive a causal explanation that closely approximates some universal truth in terms of measurable outcomes and relationships (Gray, 2013; Greene, 2007; Ulin *et al.*, 2005). Though it is an oversimplification, positivistic research is commonly referred to as quantitative research in popular discourse. In keeping with this convention, the terms are used interchangeably throughout this paper.

Preferences for quantitative information in environmental decision-making are upheld at the expense of qualitative findings and other differentiated information sources, such as local and Indigenous knowledge (Martin, 2007). This paper uses the definitions of local and indigenous knowledge put forth by Berkes (2012) who defined local knowledge as the relatively recent, place-based knowledge of a group of people, and indigenous knowledge as local knowledge held by indigenous peoples, or the local knowledge unique to a given culture or society (Berkes, 2012, p. 9). Scientists and decision-makers trained in positivist epistemology may distrust or reject alternative knowledge sources that do not adhere to positivistic standards of rigor (Martin, 2007). For example, rigor in quantitative research is reliant on external validity, the extent to which the findings of one study can be applied to other situations. Meanwhile, qualitative research adhering to the constructivist paradigm understands truth and meaning to be constructions resulting from the interaction between individuals and their social world (Ulin *et al.*, 2005). In other words, universal truth is unlikely to exist. As a result, the findings of qualitative social science research are based on lived experience, which is usually specific to only a small number of particular environments and individuals (Shenton, 2004). The same example can also be extended to Indigenous knowledge, which is consistent with many of the tenets of constructivism in its rejection of the positivist belief in context-free generalizations and valueless inquiry (Berkes, 2012). For simplicity, the term place-based knowledge is used in this paper in reference to knowledge from both qualitative social science, and local and Indigenous knowledge.

An overreliance on information provided by quantitative research may not convey the full range of knowledge necessary for environmental governance efforts (Ascher *et al.*, 2010). This information deficiency constitutes a bounded rationality bias, whereby people make reasonable decisions based on the information they have, despite having imperfect or insufficient information. Particularly deficient is knowledge about parts of a system that are spatially or conceptually distant from one's own frame of reference (Meadows & Wright, 2008; Simon, 1972). Conventions that marginalize place-based research and local and Indigenous knowledge can lead to decisions that have negative environmental outcomes or

cause disproportionate harm to underrepresented groups (Martin, 2007). Other practical justifications for increased representation of local and Indigenous knowledge in research and decision-making processes are to encourage more active participation from previously excluded voices, to generate culturally appropriate adaptation responses, and to increase local support of resulting initiatives (Ascher *et al.*, 2010; Lemos, 2008; Nelson *et al.*, 2007).

4.2.3 Boundary objects:

Shortfalls in the accurate assessment and use of knowledge are often related to information that is difficult to quantify, or more specifically, that practitioners lack the tools to properly evaluate (Meadows & Wright, 2008). This is particularly true of traditional knowledge, where face-to-face discussions between local and scientific experts are often fraught with mistranslation due to differences in perception (Eira *et al.*, 2013). Boundary objects are a tool to help address this challenge. They are scientific objects that inhabit several intersecting social worlds while satisfying the informational requirements of each of them (Star & Griesemer, 1989). These tools support the work of organizations and individuals who actively facilitate collaboration across disciplinary and cultural boundaries. Scientific visuals fall into a category of boundary objects named "ideal types", a concept originating from German sociologist and philosopher Max Weber (1904). Ideal types are heuristic tools that provide a simplified or abstracted version of reality and are employed by users to gain a better understanding of empirical reality (Swedberg, 2018). Among ideal types, visuals provide a means of communicating and cooperating symbolically. For example, maps are considered useful ideal types because they create a common ground from which all participants can build understanding (McGreavy *et al.*, 2013; Star & Griesemer, 1989).

4.2.4 Visuals in quantitative and qualitative research:

Visual representation is the selection, transformation, and presentation of data or qualitative concepts in a visual form that facilitates exploration and understanding (Lurie & Mason, 2007). Visual tools are defined

within this project as the range of products (e.g. maps, drawings, photos, flowcharts, animations), which can be assumed to have different functions and uses in meaning construction (R. Meyer *et al.*, 2013). For example, graphic displays and tabular displays are suited to different kinds of information. The structure of displayed data in graphs creates visual patterns, while the visual appearance of tables is not affected by the characteristics of the data displayed (J. Meyer *et al.*, 1999).

According to philosopher, anthropologist, and sociologist, Bruno Latour, advancement in the sciences is enabled by images and inscription. Each scientific discipline has a standardized language or code that enables what Latour termed "immutable mobility", the ability to send information to spatially or temporally distant places with minimal change in the content or the meaning being conveyed (Latour, 1986). Scientific visuals have the quality of being "flat" or abstracted, with detail-rich observations of reality turned into generalizable scientific information in the form of charts, diagrams, and technical line drawings with limited color, texture, and perspective (Kress & Van Leeuwen, 1996). Latour comments, "If scientists were looking at nature, at economies, at stars, at organs, they would not see anything… Scientists start seeing something once they stop looking at nature and look exclusively and obsessively at prints and flat inscriptions" (Latour, 1986, p. 15). That is to say, ideal types like models and diagrams allow scientists to focus on a piece of the whole, thereby minimizing distraction and helping to convey understanding.

Explanation in scientific writing is achieved using a combination of images and inscription (Latour, 1986). Though the natural/physical sciences and the social sciences are grounded in different epistemologies, the systems of explanation employed by each are notably similar. Latour notes, "there is no detectable difference between natural and social science, as far as the obsession for graphism is concerned" (Latour, 1986, p. 15). Quantitative images are consistent with positivistic concerns for generalizable 'truths' and 'hard facts', with ideally all detail subtracted save for what is necessary to fulfill their descriptive intent (Kress & Van Leeuwen, 1996). However, when the topic of explanation is entangled with local values and connection to place – concepts difficult to quantify or generalize –

contextual detail in imagery is necessary. Visual artifacts, such as color, perspective, and typography, enhance the potential to express identities and values, thus augmenting the explanatory capacity of text and narrative (Van Leeuwen, 2011). Furthermore, visuals have the added benefit of communicating complex concepts with an "immediacy of reception and a memorable impression of the essence of the message", which is difficult to achieve with concise text (R. Meyer *et al.*, 2013, p. 496).

4.2.5 Context-rich images:

The term "context-rich image" is applied in this study to describe visual tools (boundary objects) that contain an abundance of detail and address the particularities of specific environments and cultures. For example, an unmanipulated photograph is a detailed naturalistic image that contains multiple "embedded analytical processes" (Kress & Van Leeuwen, 1996, p. 50). That is, beyond the primary subject of a photograph, the audience may also obtain information about numerous other details such as weather, time of day, and cultural norms (e.g., clothing). Abstracted images like maps, diagrams, collages, and other informational devices can also be created to convey rich context by embedding them with elements of local culture (e.g. people, activities), highlighting the unique environmental character (e.g. temporality, morphology), or by emphasizing interconnections within the regional social-environmental system.

While there are a host of ways to describe and analyze visuals, this study was primarily concerned with their denotative and connotative functions (Barthes, 1978). That is respectively, what each image describes about the subject depicted, and the way the image is interpreted in the context of environmental decision-making in the Western world view. The key focus related to denotation is informed by Latour (1986) who contends that the value of specific inventions in writing and imaging is their contribution to the content and clarity of a message. For the purposes of this study, the value ascribed to context-rich images is determined by the extent to which they can provide additional layers of detail beyond what could be made available in concise text, including information about the local environment and people's relationship to it. With respect to the connotative functions of context-rich images, the primary focal point

is the audience (public sector resource management practitioners) and their reception of the images. Among users of environmental information, diverse actors with different mental modes of understanding – an individual's set of assumptions for how the world works – often disagree about what constitutes reliable and useful knowledge (McGreavy *et al.*, 2013; Van Wyk *et al.*, 2008). Differences in the reception of visuals between the general public and the scientific community have been explored in the field of social semiotics. Kress and Van Leeuwen (1996) assert that, while the general public ascribes greater truth to naturalistic images like unmanipulated photographs, academic audiences accord greater truth to abstracted images of generalizable scientific information (Kress & Van Leeuwen, 1996).

4.3 **Materials and Methods**

The procedures used in this study are consistent with widely used techniques in media reception studies originating from a broad range of fields (e.g. communication and media studies, psychology, social semiotics) on how recipients interact with visuals and media messages (Holsanova, 2012). This study comprised four parts including the following: 1) data collection and analysis from the original parent study on adaptation to climate change in northern communities, conducted in collaboration with the Native Village of Wainwright; 2) visually representing major themes from Part 1 with photography, photomontage, and Native artwork; 3) completing an audience study in which natural resource management professionals were interviewed to help identify the primary target audience, and to inform the study design according to the informational needs and conventions of public sector decision-making; and 4) conducting a formative study using the resulting survey instrument with additional follow-up interviews to determine the validity of the study design, and to gain initial insights on the value of context-rich images for communicating place-based information to decision-makers.

4.3.1 Part 1: Parent study data collection and analysis

This formative study focused on data drawn from a parent study conducted with the Native Village of Wainwright on Alaska's North Slope. The project, reported in Sec 1.5 of this dissertation, was the outcome of an iterative process developed and conducted in partnership with the Wainwright Traditional Council and with guidance from a project steering committee comprising three local leaders.

Study area:

Wainwright (traditionally Ulguniq) is a coastal community located about 120 kilometers (75 miles) by air southwest of Utqiagvik (Barrow), AK. With a population of about 550 (Department of Labor, 2018), it is the third largest village in Alaska's North Slope Borough. Ninety percent of its residents are Iñupiat . Wainwright's climate is Arctic marine, characterized by long cold winters and short, cool summers.

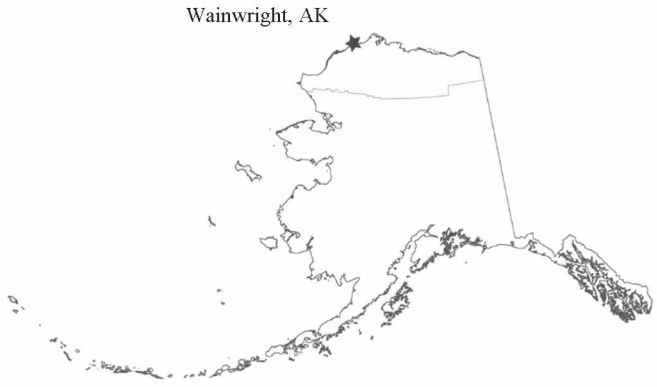

Figure 4.1: Wainwright, Alaska and North Slope Borough boundary line

The Wainwright community has undergone significant changes throughout history. Today, while many features of the Western lifestyle pervade local culture, traditional values continue to play a central role in day-to-day life. The Iñupiat residents of Wainwright live a mixed cash and subsistence lifestyle that remains dependent on fishing, gathering, and hunting on land and in the ocean for physical and cultural nourishment. The bowhead whale is of particular significance to Iñupiat culture with the entire community participating in activities surrounding the spring and fall hunt (Wainwright, 2016).

Like many North Slope communities, Wainwright is already experiencing the effects of climate change. Seasonally reduced and thinning sea ice is causing shifting animal migratory patterns, eroding shorelines, and a number of other environmental changes. Uncertainty related to these changes is further

compounded by the varied economic challenges and opportunities (e.g. arctic shipping, tourism, resource extraction) that create a complex dynamic for Wainwright decision-makers to address.

Data collection, management and analysis:

Interviews (15) were conducted with 17 long-term residents from the Village of Wainwright. Selection criteria for interview participants included community members that (1) were age 40 or older, (2) had resided in Wainwright the majority of their lives, and (3) had significant experience outdoors in the Wainwright Traditional Use Area. Semi-structured, in-depth interviews (Denzin & Lincoln, 2011) focused on each participant's observations of change throughout their lifetime as well as family and community scale adaptations in response to unexpected events, environmental changes, economic development, and other factors. The interviews were transcribed verbatim and then content analyzed using NVivo (version 11) qualitative data analysis software.) For additional details on participant selection, data collection, and analysis protocol please see Sec 1.5 Methodology.

The contextual analysis of transcribed interviews yielded rich information. The most endorsed, environmentally influenced challenges causing concern to participants included challenges related to whaling (e.g. timing of migration, thinning ice), and seasonal change (e.g. timing of seasons, late freeze-up/early break-up of ocean and rivers). The complete list of themes and their operationalizations were presented to the Wainwright Traditional Council for validation of accuracy. Key themes were then used to inform the design of research materials including context-rich images and sample reports summarized in Parts 2 and 4 of the study methods below.

4.3.2 Part 2: Visual representation of major themes

Context-rich images were developed for this study via Native art, photographs, and photomontage. Researchers collaborated with Village of Wainwright administrators in a solicitation process to commission artwork by a North Slope artist of Iñupiat heritage. The inclusion of Native artwork provided

images from a local perspective and outside the compositional structures of Western culture (Kress & Van Leeuwen, 1996). The artist, George Leavitt of Utqiagvik (name used with permission), drew inspiration from interview themes and direct quotes (from the parent study) related to seasonal change, sea ice variability, and their impacts on hunting and transportation. Examples of Mr. Leavitt's work used in the project are shown in Figure 4.2 and Figure 4.3.

Figure 4.2: "Duck hunting in spring". George Leavitt, 2017.

Hunters must exercise caution when traveling along shore ice in the early spring. It is best to travel with a partner.

Figure 4.3: "Getting close to the lead", painted scene on baleen. George Leavitt, 2017.

Depicts Iñupiat whalers breaking trail to open lead. Decreased sea ice leads to increased winds, which in turn push pressure ridges against village shorelines, making trail-breaking hard work

Additional context-rich images used in the study were derived from photographs depicting Iñuit hunters and their relationship to sea ice. For example, the series of photographs below creates a narrative of the mobility of ice floes and attempts to illustrate the challenge presented to hunters by increasingly distant floes as a result of declining sea ice.

(a) USFWS 2006, (b) USGS 2010, (c) Photo of Willie Hoogendorn by Boogles Johnson, taken east of Cape Nome, May 2018

Figure 4.4: Sea ice coverage impact on walrus hunting

Walrus remain in the vicinity of coastal villages as long as there is pack ice nearby. This important food source is less accessible to hunters when ice floes are far out to sea

The photomontage image below combines the abundant detail of a photograph, with the abstracted reality and descriptive function of a diagram. The photograph shows the visible aboveground, and the diagram is an artificial depiction of the "invisible" sub-surface. The photograph in this case was chosen to convey scale and magnitude, including the enormous mass of a bowhead whale and the substantial number of people involved in the whaling process. The photo also serves to emphasize the relationship between people, whale, and sea ice. The diagrammed portion is intended to draw the reader's attention to the important dynamics below the sea ice surface, in particular the minimum thickness needed to sustain the whale's weight for a safe and successful harvest.

Figure 4.5: Sea ice thickness and whaling

A minimum 3-4 feet of ice thickness is needed to support the weight of a whale

Images were selected for inclusion into the sample report materials (see Part 4) based on their ability to provide useful information and assist in advancing the reader's interpretation. Additionally, the visuals had to be presentable, readable, and combinable with text in the format of an otherwise conventional report (Latour, 1986). These production decisions were made based on an understanding of how a hypothetical recipient in the target audience would likely perceive the material. This understanding was informed by theories in social semiotics (Kress & Van Leeuwen, 1996) and an audience study involving key informant interviews summarized in Part 3 below. Additionally, the selection of visuals for this study was determined by other practical considerations such as the social (Curry, in prep) and natural science (various sources) research they were intended to augment, and a desire to include multimodal media for the sake of comparison.

4.3.3 Part 3: Audience study (key informant interviews)

The messages conveyed by media cannot be assumed to be static or singular (Livingstone, 1998). Instead, the reception of media is dependent on the audience and its cultural context (ibid.). Having identified public sector resource management practitioners as the target audience for this research, an audience study was conducted to gain further insight into the characteristics of this group and possible sub-groups,

and also to obtain guidance on study design, and the conventional treatment of place-based information for decision-making within environmental management agencies. An additional consideration for the audience study was based on the practical consideration of developing boundary objects that are useful to decision-makers. The integration of context-rich images into technical reports is unconventional. For new approaches to become adopted as standards, it is necessary they be congruent with existing decision tools that are already well-accepted (Rayner *et al.*, 2005).

Five key informants provided insights during interviews that lasted between 30-60 minutes. Participants included two senior-level wildlife scientists and one senior-level social scientist from federal agencies in Alaska, and two information/decision support specialists working for two Alaska-based boundary organizations.

Role of place-based information in decision-making:

Key informants discussed a generally recognized need for place-based information, including local and Indigenous knowledge, for planning and decision-making in Alaska. However, the extent to which practitioners actually utilize this information in their own work depends on their responsibilities. For example, inseason fishery managers are concerned with catch rates, the status of stocks, and species quotas within a particular season. Based on this information, they announce fishery openings/closures and may prohibit the retention of certain species to ensure the amount caught does not exceed the annual set limit. These decisions are often made "on the fly" with limited time for deliberation and consultation. As such, inseason managers work almost exclusively with quantitative data and see little need for place-based information. However, place-based information is believed to be more integral for post-season assessment, which attempts to understand the impacts of inseason management decisions on the fishery. Public meetings are held to obtain stakeholder feedback, which then becomes part of inseason policy for the next season.

While some tasks are inherently more quantitative than others, adherence to accepted information sources within an organization is seemingly also driven by bias. While inseason fishery managers may not consider place-based information beneficial for their work, there may be occasions where additional knowledge of context has an influence on the way data is interpreted. Conservatism (adhering to what is perceived to be 'normal') and complexity are the principal factors affecting the use of differentiated information sources (Rayner *et al.*, 2005). Conservatism is reinforced by organizational reward structures that motivate practitioners to adhere to industry standards and procedures, making them resistant to experimentation with new approaches (ibid.). Similarly, complexity makes new information difficult to integrate into existing decision-making tools that are well-ingrained within the organizational culture (Rayner *et al.*, 2005).

Current conventions for place-based information:

Place-based information is typically reported in agency documents using descriptive text and direct quotes from research participants. One key informant expressed frustration that many of her quantitative-minded colleagues were unwilling to engage information in this format or to accept it as reliable. While she assigned a high level of importance to data in the form of written quotes, others perceived it as anecdotal and untrustworthy. She reported having greater success summarizing the same information in table format. By adapting place-based information to quantitative representational techniques, the original data lost some richness but was able to reach more people. When asked for examples of place-based visuals used to convey place-based information, all key informants cited familiarity with the use of photographs for this purpose. No other images types were referenced.

Ascher et al. (2010) suggest that the presentation of environmental information to decision-makers should avoid segregating knowledge based on different approaches to minimize the likelihood that decision-makers will ignore or neglect differentiated sources of information and the values it reflects (Ascher *et al.*, 2010). Public agency key informants reported they did not typically see local and Indigenous knowledge presented alongside formal science. These distinct information sources were frequently included in

different sections of the same report, but rarely together. For example, environmental assessments, conducted as part of the National Environmental Policy Act (NEPA) review process, typically separate the evaluation of the physical environment, the biological environment, and the social and economic environment into three distinct sections. Information sourced from local and Indigenous knowledge is generally organized into the social and economic section.

Target audience:

Guidance from key informants suggested that agency personnel of mid to upper-level seniority are the most likely group to encounter mixed quantitative-qualitative information. Individuals in these positions have broad job responsibilities that necessitate a wide range of information sources, and the authority to make decisions based on that information. Knowledge goes through a process of screening and framing before it makes its way to senior administrators (Ascher *et al.*, 2010) who have limited time to spend on each decision. According to key informants, these administrators are more likely to rely on summarized information in tables, graphs, and charts, with text functioning as a secondary, albeit necessary, source of information. For this reason, context-rich images may be particularly useful for those managers who lack sufficient time to engage with detailed place-based information.

Other considerations:

Key informants also suggested that the target audience (decision-makers) would require brevity and concise information in the study design. Sample reports given to participants could take the form of a policy or issue brief that is 2-3 pages in length and adhering to a familiar report structure with an introduction, supporting information and a conclusion or key takeaways. It was important that the test reports satisfy participant expectations for trustworthiness so the impact of context-rich visuals could be evaluated independently of other confounding variables that may influence participant responses. In reference to determinants of trustworthiness, informants mentioned several factors including authorship, funding source, citations, quality of writing (e.g. grammar, spelling), quality of graphics (e.g. accuracy,

legibility), and having a logical argument where the information presented supports the conclusion. Additionally, it would be important to ascertain participants' preexisting biases related to their disciplinary background, the perceived importance of local and Indigenous knowledge in their daily work, and their general learning style; particularly whether they are predisposed to quantitative or qualitative information and whether they had a preference for images versus text.

4.3.4 Part 4: Formative study

Overview:

Insights from the Part 3 audience study were incorporated into the formative study design. Participants were asked to complete an online survey, which involved the sequential review of three versions of a two-page report on sea ice variability and its impact on hunting and transportation in coastal North Slope Alaska communities (see Figure 4.6). Report A (baseline) was designed to follow current norms with text that summarizes knowledge from the natural sciences, and conventional graphics (e.g. tables, graphs, charts, and maps). Report B (baseline + place-based text as quotes) contained the same information as A with the addition of quotes from Wainwright residents (see Sec 1.5 in this dissertation). Report C (baseline + place-based text as quotes + place-based images) contained the same information as B with the addition of context-rich images. Participants were also asked take part in an open-ended follow-up interview to obtain constructive feedback regarding the research topic and study design.

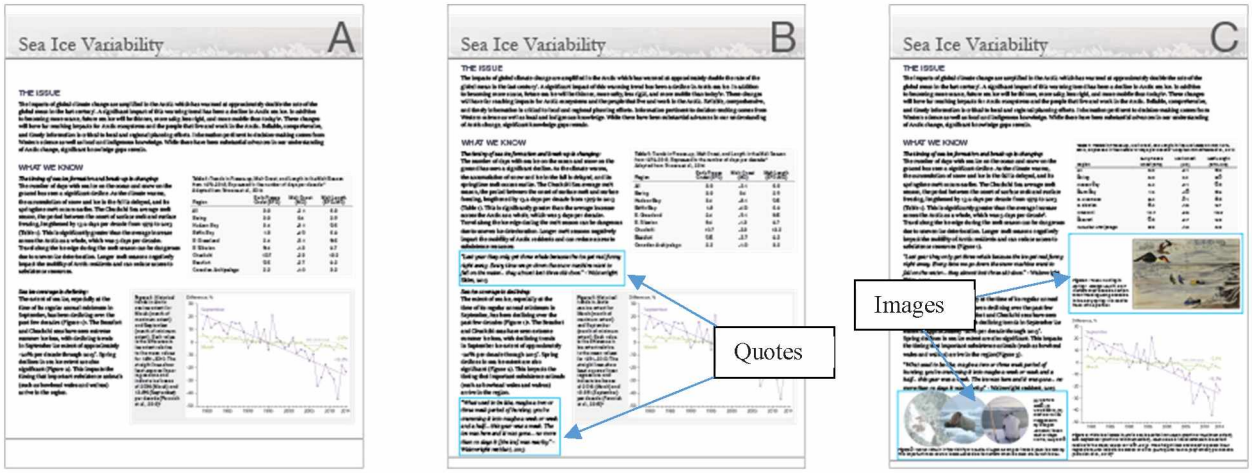

Figure 4.6: Sample reports A, B, and C

Participants and recruitment:

Study participants were practitioners who possessed: 1) expertise in environmental policy, planning, and/or decision-making, and 2) decision-making influence within their agency or organization. Participants were identified based on recommendations from senior managers at Alaska state and national agencies/organizations involved in environmental management and research.

Survey:

The survey comprised five distinct sections; 1) Background, 2) Report A questions, 3) Report B questions, 4) Report C questions, and 5) Wrap-up /Feedback questions (see Appendix A).

The **Background** section included questions intended to gain an understanding of the prior knowledge and attitudes of participants (Arpan *et al.*, 2006). Questions inquired about each participant's job and responsibilities, familiarity with North Slope Alaska, experience with and perception of local and Indigenous knowledge in environmental decision-making, and their learning preferences on a spectrum from highly textual to highly visual. Participants were also asked what factors of a report used in environmental planning/decision-making influence their view of its credibility. Credibility is defined as

the factual reliability and competence of the knowledge being shared, including technical proficiency, and subject matter-based or place-based expertise.

Report A (baseline) questions inquired about participant perceptions of the report's overall clarity (ability for the content to be clearly and quickly understood) and the credibility of the information within. For each figure depicted in Report A, participants were asked to rate the figure's ability "…to improve [their] understanding of the information provided in the report" on a four point scale from "not at all" to "very much so". The option "not applicable (N/A), I didn't look at the figure" was also provided. Ability to facilitate 'improved understanding' was used as a metric for value-added given the utility of the graphic in the described report context is determined by its ability to contribute additional descriptive capacity beyond the other inscriptions (text and other conventional graphics) already present (Latour, 1986). Although the focus of this study was context-rich images, these questions were included for the conventional graphics in Report A to establish a baseline. The rationale was that a participant who ascribed no benefit to conventional graphics, nor context-rich graphics provided an indication of other confounding factors such as participant bias or a flaw in the selection of images used in study.

Questions related to **Report B** (baseline + quotes) were intended to provide insight into the effects of displaying information from both Western science and local/Indigenous knowledge systems alongside one another. The first question asked how the inclusion of quoted statements from local people impacted the participant's understanding of the issues described in the report. Participants were then asked to rate Report B as more, less, or equally credible to Report A. The purpose was to investigate whether those who may be inclined towards Western science and quantitative information would ascribe less credibility to a report that included alternate information sources; a presumption made by a key informant (interview #1) and also supported by visual theory (Kress & Van Leeuwen, 1996).

Report C (baseline + quotes + context-rich images) questions followed the same pattern as Report B, but further focused on the impact of locally-based photos and art on the participant's understanding, and the credibility of Report C in comparison to Report B. For each context-rich image, participants were asked

to rate the extent to which the image improved understanding of the information provided in the report. Uniquely, for each context-rich image, participants were asked what, if any, information the figure conveyed above and beyond that provided in Reports A and B. This prompt probed the ability of images to function as information in addition to their role as devices that help facilitate audience comprehension of textual information. Ability to provide additional information as opposed to improved understanding of existing information was treated in this study as a separate concept and an additional benefit.

In the **Wrap-up** section of the survey, participants were asked to rate the usefulness of the three approaches represented by each report (A. baseline, B. baseline + quotes, and C. baseline + quotes + context-rich images) based on their ability to convey information. Participants were also asked to choose which, of the reports (A, B, C) they preferred given the intended purpose; "to provide an understanding of current knowledge on key components of sea ice variability on the North Slope of Alaska as well as an understanding of the local context and experience of these changes". Additional wrap-up questions pertained to the study process, such as the amount of time taken to complete the survey, study aspects considered to be confusing or ambiguous, and suggestions for further lines of inquiry that would be beneficial for the study.

4.3.5 Follow-up Interviews:

As a follow-up to the survey, semi-structured, in-depth interviews were conducted to gain additional insight into participant survey responses and perspectives, and to assess survey validity. The interview protocol included a standard set of five open-ended questions as well as probes to allow participants to clarify and elaborate on details provided in their initial survey responses. Follow-up interview questions and the rationale for their inclusion are provided in Table 4.1.

Table 4.1: Follow-Up Interview Questions and Rationale

Question	Rationale
1) Do you have any thoughts about the topic (knowledge communication and the integration of different sources of information for environmental management) or the survey itself that you'd like to share?	Opportunity for participants to discuss any thoughts they have at the outset of the interview
2) In a few instances in the survey you were asked how the inclusion of quotes or locally-based photos and artwork impacted your understanding of the issues described in the report if at all. Please tell me your interpretation of what the phrase "impacted your understanding of the issues" means.	A diversity of responses to questions with the phrasing "impacted your understanding of the issues" prompted the inclusion of follow-up questions to verify whether or not participant's interpretation of the question matched that of researchers
3) Did the images in Report C provide any additional nuance or detail that wasn't available in the text or quotes (Reports A and B)?	Responses to survey questions about information conveyed by images in Report C above and beyond Reports A and B were generally not distinct from responses related to questions about improved understanding of existing information. The question was asked again but rephrased in the follow-up to include the terminology additional nuance or detail in place of information.
4) Report B (baseline + quotes) and Report C (baseline + quotes + images) represented a couple approaches to combining information from natural science with social science and local observations. How effective were each of these approaches? Is there a better way to achieve this integration? Is this a challenge you have dealt with in your work?	Regarding the challenge of integrating knowledge from Western science and local and Indigenous knowledge to inform environmental decision-making, the survey asked about how the inclusion of quotes and images impacted the perceived credibility of the sample reports. Additional insights on this topic were requested during follow-up interviews.
Do you have any additional insights on prioritizing report content when considering page limit guidelines?	Constraints in sample report length were dictated by brevity as a major consideration for information used by upper-level environmental managers. Participants were asked for additional insights on this topic

4.4 **Results and Discussion**

Eight practitioners from six public agencies completed the survey intended to evaluate the potential of context-rich images to facilitate the cognition of place-based themes, and understand the advantages and disadvantages of combining information from Western science and local/Indigenous knowledge systems into one report. The survey was open online for one month and took an average of 40 minutes to complete. Responses to background questions are reported in Table 4.2. On average, participants rated

themselves good (4.1 out of 5) regarding their familiarity with *environmental* issues on the North Slope of Alaska and fair to good (3.6 out of 5) in terms of their familiarity with *social* issues in the region. Participants on average rated local and Indigenous knowledge as being high (4.5 out of 5) in terms of its value as an information source for environmental planning and decision-making. Respondents on average rated themselves neutral (3.25 out of 5) in terms of their learning preference (textual to visual).

Table 4.2: Survey background question summary

Background questions	Mean / %
How would you rate your familiarity with environmental issues on the North Slope of Alaska? **Scale:** 1 (Not at all) to 5 (Very)	4.13
How would you rate your familiarity with social issues on the North Slope of Alaska? **Scale:** 1 (Not at all) to 5 (Very)	3.63
How would you rate your level of experience working with Indigenous peoples in Alaska? **Scale:** 1 (Not at all) to 5 (Very)	3.63
Local and/or Indigenous knowledge are among the information sources I use in environmental planning **Scale:** True/ False/ Not-applicable	75% True 25% Not applicable
Local and/or Indigenous knowledge are among the information sources I use in environmental decision-making **Scale:** True/ False/ Not-applicable	50% True 50% Not applicable
How valuable do you think local and/or Indigenous knowledge are as sources of information for environmental planning/decision-making? **Scale:** 1 (Not at all) to 5 (Very),	4.50
Given your rating of the value of local and/or Indigenous knowledge, how much attention do you believe it receives in environmental planning/decision-making? **Scale:** 1) Not enough, 2) Just enough, 3) Too much	1.25
The number that best describes your learning preference is: **Scale:** On a scale from 1 (Highly textual) to 5 (Highly visual)	3.25

Of the participants, six also completed a follow-up interview. Follow-up interviews were conducted over a period of one month via telephone and lasted an average of 30 minutes. With each participant's permission, the interviews were audio-recorded, transcribed, then coded and analyzed by the lead author using NVivo (version 12) qualitative data analysis software. Findings regarding the survey structure and sample report content are summarized below.

4.4.1 Reflections on sample report structure and content:

Survey respondents rated Report A (baseline) as being relatively high (3.2 out of 4) on clarity. As described by participants, the report format was familiar and so they were accustomed to seeing information delivered in this manner. In open-ended survey responses, participants described Report A as "clearly written", "straightforward", "balanced", "basic", and "organized to be a quick read".

Participants noted technical issues with Report C (baseline + quotes + context-rich images). It was suggested that the images were too small, which would make them difficult to interpret in a printed report, but were acceptable for the electronic format in which they were viewed as readers had the ability to zoom in closely. One participant described Report C as "kind of busy and crowded", noting that it may have worked better as a 3-page document.

The target audience for the sample reports and survey was identified as agency personnel of mid to upper level seniority with decision-making influence, and experience in environmental policy, planning, and/or decision-making. However, participant comments and follow-up discussion revealed that there was significant diversity within this target with respect to familiarity on North Slope issues. It followed that the resulting reports and survey, which were targeted to people with average familiarity, missed the mark for the most expert respondents. Three participants rated their familiarity with North Slope environmental issues as being very familiar (5 out of 5), and two participants rated their familiarity with North Slope social issues as being very familiar (5 out of 5). Members of this group were already familiar with the content of the report and rated the images (both conventional and context-rich) as providing little in the

way of improved understanding or additional information. Follow-up interviews revealed in most cases that this opinion was more a reflection of the respondents existing knowledge of the subject than the value they were attributing to the images. One respondent shared:

> "I think the problem I had with the survey a little bit, with the question does this increase *your* understanding of the topic, seemed like it wasn't really the right question for someone like me because… almost none of that was new to me…" (Follow-up interview participant #6)

Most expert participants noted that, while for themselves the images provided no additional understanding or information, they could see the value for non-expert audiences, as indicated in the quote below:

> "The inclusion of the photographs and artwork didn't affect my understanding, but I think they're a valuable addition because they add to the human element provided by the quotes, and they get the attention of the reader. This might be particularly important for the non-expert reader, who might be more encouraged to read more if the photographs and artwork act as an initial hook" (Survey participant #5)

4.4.2 Reflections on credibility:

Survey participants were asked to rate the perceived change in credibility for each version of the report. The results are summarized in Figure 4.7 and detailed further below.

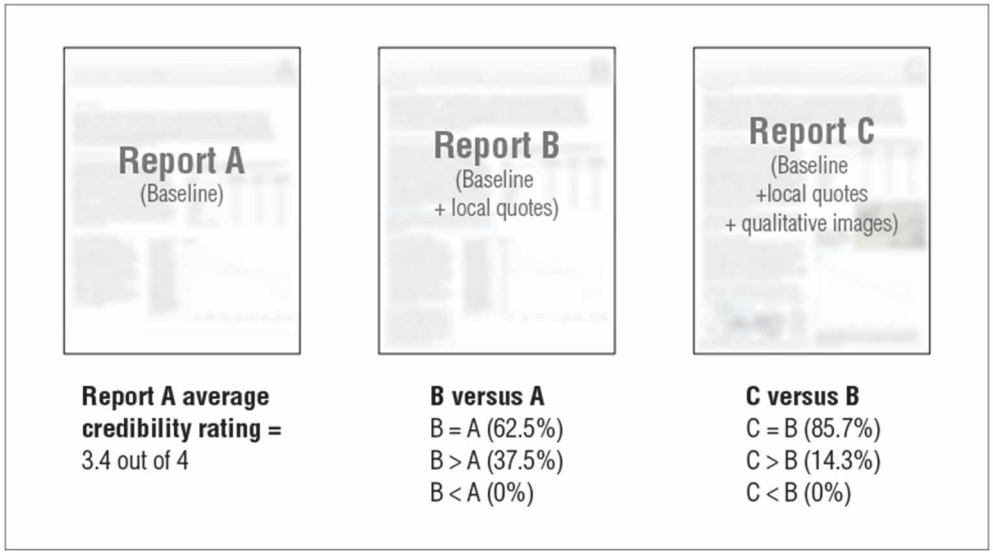

Figure 4.7: Report credibility comparison

Report A (baseline) was rated on average as being relatively high (3.4 out of 4) for credibility (Figure 4.7). Open-ended survey responses provided insight into participant ratings, which were based on the presence of citations from peer-reviewed literature, statistic trends, and the inclusion of information about gaps in current knowledge related to the topic. Other factors that survey respondents identified as influencing their opinion of a report's credibility were consistent with those identified in key informant interviews.

Participants rated **Report B** (baseline + quotes) as either equally (62.5%) or more (37.5%) credible than Report A (baseline) (see Figure 4.7). One respondent noted:

> "[Report B] would certainly be more credible to a wider audience, and adds human, on-the-ground verification of the scientific findings." (Survey participant #6)

Another participant suggested that more information is needed to demonstrate the quotes represent regionally corroborated observations and not just a single individual's opinion:

> "I like report B better because it presents information about the social relevance of the issue. Because the information is in the form of individual quotes without evidence that the statements have been corroborated by others in the region, I hesitate to call it more "credible"" (Survey participant #1)

Participants rated **Report C** (baseline + quotes + context-rich images) as either equally (85.7%) or more (14.3%) credible than Report B (baseline + quotes). One respondent explained:

> "For me, these particular images don't add or detract from the credibility, though they do add some really key perspective." (Survey participant #2)

Kress and Van Leeuwen (1996) posited that scientifically trained audiences are likely to ascribe greater truth to abstracted images of generalizable scientific information. These findings show that the same audience may also find context-rich images to be trustworthy. Still, as one respondent commented, medium is another factor that influenced each images impact on the perceived credibility of the report:

> "I would say that the artwork [paintings], makes the report less credible, while the other photos/graphics add to one's understanding." (Survey participant #6)

Additional insights on this topic were shared during the follow-up interview. The inclusion of paintings was characterized as "distracting" because the reader then had to engage with and make value judgements about the art that were not related to the core message of the report. Additionally, the paintings seemed to have a different voice than the rest of the report. This led the participant to wonder if there was some other underlying message being conveyed with their inclusion (Follow-up 6). The addition of context-rich images undoubtedly changed the document's tone. *Tone*, one of six visual cognates described by visual communication scholars Kostelnick and Roberts (1998), is the voice of the document, which is established by typography, color, layout, and images (Kostelnick *et al.*, 1998). For example, Figure 4.3 was painted on baleen (a keratin-based system inside the mouths of baleen whales used to filter food such as krill from the ocean) and perceived by the same participant as "just too flowery" for the document and its intended audience (Follow-up interview participant #6).

4.4.3 Reflections on context-rich images: Image ratings and salience

When asked to choose which, if any, of the reports (A, B, C) was preferred given the intended purpose (to provide an understanding of current knowledge as well as the local context and experience of Northern environmental changes), 7 out of the 8 respondents chose Report C. The remaining respondent chose Report B. The majority opinion is reflected by the following quotes:

> "For the first part of the purpose, you only need report A and/or B. To meet the second part of the purpose (i.e., both context and experience), you must have report C" (Survey participant #2)

> "Sometimes there are measurable changes that don't impact communities. The quotes are really key in demonstrating that the documented changes are impactful. Not all off the pictures necessarily increase the credibility of the document or provide key information -- some do – but they all provide visual context to the statements and quotes so that the reader can picture what is going on, even if they have not been to the North Slope." (Survey participant #1)

As the above quote suggests, some of the images were more successful than others at enriching the information in the report. Figure 4.5, the montage image illustrating the importance of sea ice thickness, was perceived to be the most successful. Its ability to place the trends of declining sea ice described by the report into a clear context was the primary beneficial quality cited.

> "[The figure] reinforces the statement it's paired with quite well, and nicely draws the connections between the academic text and the quote" (Survey participant #2).

The lowest rated image was Figure 4.2. The primary focal point of the painting (depicting two young men struggling with a snow machine that has broken through ice) was inadvertently under-scaled and consequently difficult for participants to interpret. Additionally, the figure was characterized as not quite the right image to describe sea ice formation and break-up trends that it was intended to support.

> "I think the figure is slightly misleading, as it illustrates a landfast ice case, yet the report is about the pack ice. Ideally, figures would be consistent with the text" (Survey participant #4).

These observations demonstrate the importance of *salience* (the strength of association between the figure and the information it is paired with) for image selection. A notable consideration regarding Figure 4.5 is that it was created by the lead author expressly as a representation of the local quote it is associated with in the report. Figure 4.2, while representative of quotes from Wainwright interviews, was not a perfect match for the specific content of the report. As one respondent notes "… graphics are really helpful, but I think it just has to be the perfect one" (Follow-up interview #6), which can be hard to find after-the-fact.

In the field of technical communication, technical documents are largely composed with verbal text in mind (Salinas, 2002). This means that visual design is restricted to the coordination of visuals as secondary to text in layout and document design (ibid.). Some technical communicators push back against this convention and argue for a more critical approach that considers the larger cultural impact of images, which are primary to how we read and communicate today, particularly in the realm of electronic media (Salinas, 2002). However, the ability of images to take a primary role as drivers of content in this study was limited by the lack of high resolution scientific observations available for the Arctic region, especially in the near-shore environment, which is the area most relied-upon by local people (Carmack *et al.*, 2015). The lack of high resolution data available via remote sensing has been identified as a challenge for local scale planning and decision-making in relation to Arctic environmental change (Vargas-Moreno *et al.*, 2016).

4.4.4 Other insights and applications:

Survey design:

Follow-up interviews revealed several insights regarding the wording and content of the formative study survey which may inform the design of future studies. These insights are summarized below.

Wording:

For researchers, the phrase "impacted your understanding of the issues" referred to the ability of quotes or images to change (e.g. expand, reduce, reinterpret) their previous perception of the issues. Follow-up interview feedback indicated there were discrepancies in participant's interpretation of this phrasing, which suggests additional detail or rewording will be necessary for future surveys.

Conceptual overlap:

Image contributions toward improved understanding of *existing* information and their capacity to transmit *additional* information above and beyond existing information were treated as separate concepts in the survey. Discussion utilizing the words *nuance or detail* in place of *information* generated additional insights. It is possible that participants who perceived an improved understanding of existing information did so *as a result* of there being additional information contained in the images, suggesting the two concepts are linked and some overlap is to be expected. However, the prompt would likely generate richer and more diverse responses with greater emphasis (e.g. bold, italics, underline) on the words *existing* and *additional,* and with the addition of *nuance or detail* as a more specific description.

Suggested additions:

A compelling comment related to suggested improvements for the survey was based on the complex nature of environmental decision-making, where best available knowledge is only one factor considered in addition to a host of other economic and political factors. In light of this, a suggestion was made to collect data on sources of information most readily used by decision-makers, including what types and amounts of information participants believe should go into a decision. The context provided by this line of questioning would help analysts and other curators of information more accurately target the content of their reports to specific decision-making audiences.

Document length:

Prioritizing content given document length restrictions is a challenge in summary-style reports. One survey respondent noted that, in practice, there are non-negotiable page limits and, often times, adding images means sacrificing allotted space for informative text, which would reduce credibility (Survey Respondent 1). In Report C, some legibility was unintentionally sacrificed for the ability to maintain a consistent amount of textual detail when context-rich images were added to the document. As survey respondents noted, the scale of Figure 4.2 was too small to clearly make out the scene being depicted. This had a negative impact on the clarity of the report and limited the amount of information the figure itself was able to convey. On the other hand, images provide some advantages for concise communication. One respondent mentioned the adage:

"A picture is worth 1,000 words, and there's a lot of truth in that… it takes a long time relatively to read 1,000 words versus look at a picture" (Follow-up interview #5).

Captions:

Respondent comments indicated that additional detail in image captions would be useful to help readers interpret context-rich images in the report. Information about the time period represented in the images and more explanation about the actions and relationships being depicted were examples cited in open-ended survey responses.

"The context of these photos is not sufficient to know what they show. There is also little information to help understand whether these show new or unique conditions" (Survey participant #7).

Potential benefits:

Participants ascribed several benefits to a reporting approach that combines information from Western science with information from local and Indigenous knowledge. One participant noted that the quotes in Report B provided evidence that the statistically detectible environmental changes summarized in the

report are significant enough to have a perceptible impact on local people. That is to say, phenomena that are detectable in the data are not always perceptible to humans, yet the quotes provide an indication that observed changes are having an appreciable impact on people's lives. Two participants commented that both the images and the quotes were beneficial because they show the societal relevance of the science and help readers understand what environmental conditions mean to people who live and work in the Arctic. Another participant observed that the context-rich images provide another tool that can be used for explanation, and are particularly helpful for readers who are visual learners. The same participant speculated that images could provide the additional benefit of making the document more interesting for certain readers because "as human beings we are naturally curious about other people".

Applications to practice:

Study participants noted several applications of this research. First, managers and policy-makers are concerned not only with scientific facts, but also with societal relevance, which the quotes and context-rich images provide. Second, effective techniques for integrating Western science and local and Indigenous knowledge would be useful for both internal and external agency communications. Internal briefing papers about the Arctic may be sent to people in headquarters offices in Washington D.C. who are far removed from changes on the North Slope. This group is likely to understand the value of local and Indigenous knowledge more if its contribution of context to Western science is made more visible. Also, in the interest of transparency, agencies must demonstrate how they are using the local and Indigenous knowledge they collect. Formatting techniques for external communications that illustrate how agencies are integrating these knowledge sources in their work are needed. Third, many people at environmental management agencies that become decision-makers are from a natural science background and tend to be wired toward hard science. One of the advantages of reporting local and Indigenous knowledge together with Western science is that it reminds decision-makers about other important factors to consider.

Additionally, the discussion of image salience in section 4.4.3 offers useful insights for the collection and application of context-rich images in practice. It can be difficult to acquire images that adequately and precisely communicate place-based research findings (e.g. the social context within which the results occur) after data collection activities have concluded. However, the fields of anthropology and sociology offer the complementary photo-elicitation method, which is likely to provide benefits both in relation to the above challenge and towards the generation of rich discussion during research interviews. Simply described, photo-elicitation involves inserting a photograph (or other visual) into an interview, which has the effect of stimulating participants and evoking responses unlikely to be obtained otherwise (Harper, 2002). In photo-elicitation, research participants themselves may be asked to provide an image for discussion, which ultimately satisfies a dual purpose of both promoting discussion and helping the researcher collect context-rich images through which study findings can be more precisely communicated.

4.4.5 Limitations and strengths:

The formative study methodology is consistent with established methods in media research commonly used to reconstruct audience reception of media (Holsanova, 2012). An initial audience study was undertaken to inform the survey and sample report design. A two-phase mixed methods approach exploited the strengths of quantitative (survey) and qualitative (interview) data (Shenton, 2004), enabling not only the identification of patterns across participants, but also the verification of findings and the collection of rich information. Flaws in the sample report design (e.g. under-scaled images) and the wording of survey prompts unintentionally influenced participant responses. However, follow-up interviews provided an opportunity to identify and correct these flaws, as well as explore affected prompts in a clearly articulated way that was true to their original intent.

The extent that research findings are grounded in the data, is strengthened by efforts to reduce researcher bias (Shenton, 2004). While two individuals coded the interview data from the parent study (a strength),

formative study interviews were coded and analyzed solely by the lead author (a study limitation). Having a single coder is considered a limitation given the absence of a potential check on researcher bias unintentionally guiding data interpretation. However, this limitation is mediated by the presence of an audit trail established through detailed description of the study's design and implementation, which allows an observer to trace the course of the research step-by-step. Furthermore, bias was addressed in the parent study with the verification of key themes that emerged from the research with local advisors in Wainwright. Additionally, Native artwork was commissioned for the project in an effort to incorporate visuals outside the compositional norms of Western culture.

The formative study sample size of eight participants was small and non-representative. However, representation of multiple perspectives within the target audience was achieved by including participants from six different public agencies. Though the results of the formative study cannot be generalized, it is a point of departure for future research, which is significant given the persistent challenge of interfacing underrepresented knowledge sources in environmental governance efforts (Raymond-Yakoubian *et al.*, 2017).

4.5 **Conclusion**

This formative study, comprising a survey and follow-up interviews, furthers the proposed methodology designed to evaluate a modified reporting approach that integrates quantitative environmental research and place-based research. The proposed methodology had two purposes; to: 1) understand the potential of context-rich images to facilitate the cognition of place-based themes and thereby assist in communicating knowledge across cultural and professional barriers, and 2) investigate from the perspective of information users the advantages and disadvantages of combining information from Western science and local/Indigenous knowledge systems into one report. Survey results revealed a strong preference for Report C (Baseline + quotes + context-rich images) to provide an understanding of current knowledge as

well as the local context and experience of Northern environmental changes. Neither the inclusion of quotes or images negatively impacted the perceived credibility of each report. Context-rich images with demonstrated benefits in the communication of place-based information beyond those already provided by textual information (e.g. quotes, narrative) likely have useful application both in information reporting techniques and for communicating place-based research in general. Furthermore an integrated approach to reporting information from two separate knowledge systems that has no adverse impact on the reception of that information can offer a means to present alternative knowledge sources on equal footing with Western science, thereby minimizing the likelihood that decision-makers will neglect or ignore it (Ascher *et al.*, 2010). This is a necessary consideration given the confines of organizational norms and disciplinary conventions, which privilege quantitative Western science over other sources of information (Lemos, 2008; Martin, 2007; Rayner *et al.*, 2005).

The study participants identified several areas for improvement in the survey and sample report design. First, there is a need for greater specificity in wording and perhaps added emphasis to key words (e.g. *existing* information/ *additional* information) in order to elicit greater consistency and precision across participants in the interpretation of question prompts. Similarly, current prompts do not function for expert audiences who are already familiar with the environmental and social issues described in the report. Second, while participants overwhelmingly indicate that context-rich images provide added value, the benefits are easily muddled by under-scaled or poorly arranged images. Additionally, images that receive the highest rating are those with the greatest salience in relation to the textual information with which they are paired. Still, the benefit of some images might be improved with more descriptive captions to assist readers in their interpretation.

Overall, this formative study shows the methodology to be a valid approach for the evaluation of visual tools and reporting formats intended to addresses a need for proven methods of knowledge brokering and communication that facilitate the transmission of place-based knowledge for decision-making (Lemos, 2015). Further research is necessary to determine if the anticipated benefits of the proposed techniques are

realized in practice, especially considering the potentially diverse range of topics and organizational settings in which they might be applied. An ideal setting for the next iteration of this research would be in collaboration with ongoing reporting initiatives within environmental resource management agencies, particularly involving communication between local/regional offices and their counterparts in state/national headquarters that are far removed from the local impact of environmental changes. Such experiments in communication are relatively low-cost and would provide valuable insight about the effectiveness of new techniques aiming to increase the usability of underrepresented knowledge sources in environmental governance.

Ethics statement:

This study was conducted in accordance with the recommendations of the Institutional Review Board (IRB) of the University of Alaska Fairbanks (IRB approval numbers: 767319-5 and 1343902-1)

Conflict of interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author contributions:

TC and EL made substantial contributions to the conception and design of the work; approved the final version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. TC and EL were involved in the analysis and interpretation of data for the work. TC drafted the work and EL revised it critically for important intellectual content.

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Appendices

Appendix A

Knowledge communication survey

See supplementary materials

Appendix B

Sample Reports A (Baseline),

B (Baseline + Place-based text as quotes), and

C (Baseline + Place-based text as quotes + Place-based images)

See supplementary materials

5. Conclusion

The three papers comprising this dissertation report on three studies that examined different aspects of local scale information blind spots impacting adaptation governance efforts concerning climate change in the Alaskan Arctic. The first study looked at conventional methods of adaptation classification, which are an example of general tools employed in broad scale initiatives that result in a low resolution image of how adaptation happens in local communities. The second study investigated the role of informal institutions in adaptation, which exert significant influence on the adaptive capacity of local communities, but remain understudied in sustainability science in part because they are difficult to quantify and analyze. Finally, the third study was a formative exploration of the communication aspects of transferring knowledge to action, and was undertaken to address information biases that marginalize place-based information like local and Indigenous knowledge in decision-making. This research was conducted with the intention to contribute to the availability of more comprehensive information that is inclusive of the range of perspectives and knowledge systems relevant for decision-making. The reported methodologies, results, and findings contribute to literature in the sustainability sciences related to bridging disconnects between diverse collaborators and stakeholders in environmental governance efforts. This research also provides actionable insights for natural resource management practitioners related to the generation, transmission, and use of local scale environmental knowledge (see Ascher's framework describing the role of environmental knowledge in policy processes in Chapter 1 of this dissertation). In particular, it highlights the limitations of generalized analysis methods, suggests complementary methods of accessing place-based information for use in decision-making, and puts forth an enhanced visual approach for conveying comprehensive information to decision-makers. A summary of the results and findings, the contributions of this research, as well as its limitations and strengths is provided below.

5.1 Place-based classification of adaptation: Wainwright, Alaska case study

Mismatches between the broad scale of what is known and the precise scale at which actions are taken is a significant challenge in global climate change governance (Cash *et al.*, 2006). This contributes to specific criticisms of global climate change literature, which contest the emphasis placed on centrally-planned adaptations involving specific technologies, polices, and programs, and the concurrent neglect of knowledge derived from social context including elements of adaptive capacity that have historically contributed to autonomous adaptation in local communities (Agrawal, 2010; Eriksen *et al.*, 2015; Nelson *et al.*, 2007; Thornton & Manasfi, 2010).

The first paper in this dissertation detailed a study of a particular mismatch between low-resolution adaptation analysis tools that are suited to international scales yet poorly suited to high resolution local places. Generalized frameworks for adaptation classification have been applied broadly to global datasets (Agrawal, 2010; Noble *et al.*, 2014) and also to regional and local contexts (Goldman & Riosmena, 2013; Trainor *et al.*, 2017; Upton, 2012). However, key local strategies and other nuances may be missed when global approaches are applied to local places. Using a case study of the Native Village of Wainwright, AK, this study was undertaken to identify key characteristics of local adaptation that are readily overlooked by conventional generalized classification methods. Directed content analysis (Hsieh & Shannon, 2005) of Wainwright interview data resulted in a place-based classification through which local nuances not captured in a general classification approach emerged. These nuances were primarily linked to the subsistence-cash economy that is particular to Wainwright and other Iñupiaq communities where residents are continuously balancing the dual need for subsistence and income. Two categories of adaptation (*mobility* and *market exchange*) were redefined based on the local context. Additionally, the contribution of basic technology as an element of adaptive capacity was another place-based insight that highlighted the importance of general advances not necessarily created for the purpose of adaptation, but that nonetheless make a difference in people's everyday lives. This finding supports the case for a

broadened international scale discourse on technological solutions that goes beyond the current focus on discrete interventions with clear outputs and outcomes (Noble *et al.*, 2014; Thornton & Manasfi, 2010).

In addition to identifying gaps in knowledge of local adaptation that are not addressed in conventional classification approaches, this study contributes insights related to the generation, transmission, and use of environmental knowledge in governance processes. The findings demonstrate the relevance of a place-based approach and the directed content analysis method for accessing more comprehensive knowledge to inform adaptation initiatives (knowledge generation). Benefits of place-based classification highlighted by the study include assisting the transfer of knowledge between social worlds, in this case an Indigenous community and the external decision-makers that influence local capacity to adapt (knowledge transmission). A place-based classification may also help agencies and organizations draw parallels between the policies and regulations they oversee, and the local actions and elements of adaptive capacity that relate to them (knowledge use). Furthermore, if successfully applied in comparative regional studies, place-based classification may serve as a means to scale-up local insights, in other words, improve the fit of local insights to large scale decision-making contexts (knowledge use).

5.2 Informal institutions and adaptation: Patterns and pathways of influence in a remote Arctic community

Numerous scholars have analyzed the role of institutions in shaping collective action and adaptation responses (Agrawal, 2010; Amaru & Chhetri, 2013; Ostrom, 2005; Upton, 2012). However, the focus has largely been on formal institutions given they are more easily identified and measured (De Soysa & Jütting, 2006). Nevertheless, informal institutions are an important consideration given there are potential benefits to be gained by identifying ways of supporting informal processes through formal measures (Agrawal, 2010; Upton, 2012). Additionally, the success of formal rules (determined by their efficiency, effectiveness, and legitimacy) is often dependent on their alignment with informal institutions (Helmke &

Levitsky, 2004; Meek, 2013; Pahl-Wostl, 2009). Given the potential merits, there is a need to better understand informal institutions and also the pathways in which particular types of institutions exert influence on particular adaptation categories (Upton, 2012).

The second paper engaged these topics through a case study of the Native Village of Wainwright, AK posing four primary queries 1) What informal institutions have bearing on adaptation to environmental change and adaptive capacity in Wainwright? 2) How do different informal institutions relate to each other and to different aspects of local adaptation? 3) What changes in informal institutions have occurred over time and what are the potential implications of these changes for local adaptive capacity and future adaptation to change?, and 4) how can the relationship between informal institutions and local adaptation be leveraged in targeted formal initiatives? Using qualitative contextual analysis, patterns of informal institution and adaptation associations in historic and contemporary situations were identified. Number of interview participant endorsements served as an indicator of influence between informal institutions and adaptation. Several key relationships stood out, but of particular note were the adaptation response *communal pooling* and the informal institution *hunting traditions*, which were co-referenced by participants in the greatest number of relationships. Furthermore, informal institutions were often associated with one another, indicating that their influence on adaptation is collective rather than individual. The Adaptation Institutional Analysis (AIA) Framework was developed as an extension of Ostrom's Institutional Analysis and Development (IAD) Framework to assist in the exploration of these complex relationships (Ostrom, 2005). Interview participants identified several informal institutions in which they observed change, and the AIA framework served as a useful tool to explore how these changes might affect future adaptive capacity based on historic pathways of influence.

Identifying the patterns and pathways through which informal institutions exert influence on each other and on adaptation in the context of the Village of Wainwright may help decision-makers prioritize formal initiatives that support local elements of adaptive capacity via informal mechanisms (knowledge generation and knowledge use). Furthermore, improved understanding of the function and potential of

informal institutions in adaptation processes may benefit adaptation outcomes by helping to align top-down policy goals with local level priorities. The AIA Framework advanced in this study is a useful tool through which the cascading effects of institutional change and policy initiatives can be explored (knowledge transmission and knowledge use). Additionally, the benefits of these findings may extend beyond the local context of Wainwright with potential to enrich the portfolio of support mechanisms available to planners and policy-makers (knowledge use).

5.3 Images as information: Context-rich images and the communication of place-based information for increased representation in environmental governance

Boundary work, involving the transmission of knowledge across different disciplines, worldviews, and scales, is a central focus in the interdisciplinary field of sustainability sciences, yet the communication related aspects of this topic remain understudied (McGreavy *et al.*, 2013). Media studies and science communication closely parallel this area of interest. Yet much of the literature related to knowledge transmission focuses on the communication of Western science to the general public and policy makers (Hansen, 2011; National Academies of Sciences & Medicine, 2017; Weichselgartner & Kasperson, 2010). This focus is consistent with prevailing biases in environmental governance where preferences for quantitative, positivistic research marginalize local and Indigenous knowledge, as well as social science of local and Indigenous knowledge for use in decision-making (Lemos, 2008; Martin, 2007). The formative study detailed in the third manuscript of this dissertation is a preliminary step towards bringing place-based information into the realm of usable environmental knowledge for decision-making (Lemos, 2015). Focusing on the context of public sector decision-making, a methodology was tested for exploring the potential of context-rich images and the concurrent reporting of information from Western and Indigenous knowledge systems. These approaches are of interest given their potential reporting applications to reduce the selective filtering of place-based information in knowledge transmission

processes, and convey comprehensive environmental information from relevant and diverse sources to decision-makers (Ascher *et al.*, 2010; Van Leeuwen, 2011).

A preliminary audience study involving interviews with key informants guided the research design and materials, which ultimately included a survey instrument, associated sample reports, and follow-up interviews. The formative study yielded rich insights that can inform future research. Several areas for improvement in the study design were identified, including a need for greater specificity in wording to improve consistency and precision across participants in the interpretation of question prompts. Additionally, the target audience of upper level resource management practitioners could be further divided into expert and non-expert subgroups pertaining to expertise and knowledge of the local context. The non-expert subgroup was the ideal target for this study. Survey results revealed a strong preference for Report C (Baseline + local quotes + context-rich images) to provide an understanding of current knowledge as well as the local context and experience of Northern environmental changes. Contrary to expectations, neither the inclusion of quotes nor images negatively impacted the perceived credibility of each report.

Due to the small sample size of the formative study, it is not possible to generalize results and findings. However, open-ended survey responses and rich discussion with practitioners during follow-up interviews provided promising insights for the application of context-rich images independently or in combination with local quotes for the communication of place-based information. Both images and quotes help relay the societal relevance of the science and help readers understand what environmental conditions mean to people who live and work in the Arctic (knowledge transmission). Additionally, context-rich images provide another tool that can be used for explanation, and are particularly helpful for readers who are visual learners. Images can be particularly useful in summary reports intended for upper-level decision makers given their ability to concisely convey details that would otherwise necessitate extended exposition in text. Based on insights gleaned from the formative study, the proposed reporting approach that combines context-rich images and the concurrent reporting of information from separate knowledge

systems merits further exploration as a promising means to support knowledge sharing across disciplinary and cultural boundaries.

5.4 Other considerations, limitations, and strengths

All three studies used data derived from interviews with Elders and other long-term residents of Wainwright, AK. The sample size of 15 interviews with 17 people is not representative of the Wainwright population (560) (Department of Labor, 2018). A small sample is appropriate for qualitative research aiming to collect rich, in-depth data with an emphasis on the participant's perspective (Charmaz & Belgrave, 2012; Singleton & Strait, 2010). Interviews were conducted until saturation was reached, where the collection of additional data produced no new insights on the issues being investigated (Glaser *et al.*, 1968). Local advisors suggested that the study would have benefitted from the inclusion of youth participants. The criteria for interview participation targeted seniors and Elders, which are a respected but small subset of the Wainwright population. Their opinions and observations may differ significantly from those of youth who also offer a valuable perspective given they are the next generation that will be confronting the village's ongoing social and environmental changes.

Several steps were taken to limit the potential for researcher bias to influence outcomes. Researchers strived to remain cognizant and reflexive of their biases related to their prior knowledge of climate change and adaptation in Northern communities (Watt, 2007). Reflexive notes and accompanying field notes served as contextual data during analysis to help understand interview responses (Rodgers & Cowles, 1993). Coding during the first of three rounds of analysis was performed by two individuals, the first author and a research assistant. Directed content analysis (Hsieh & Shannon, 2005) was used in team-based codebook development in which a high level of intercoder agreement was achieved. The research assistant contributed alternative insights that were valuable to the analysis. Additionally, the presence of a second coder benefits the study as a potential check on researcher bias unintentionally guiding data

interpretation. The next rounds of coding specific to adaptation classification and informal institutions were performed solely by the first author (a limitation). However, this limitation was mediated by multiple stages of member checking in which the project steering committee and other local advisors in Wainwright were consulted to validate inferences and initial research findings (Shenton, 2004).

Trustworthiness

Shenton (2004) outlines four main criteria for ensuring trustworthiness in qualitative research; credibility, transferability, dependability, and confirmability. The limitations and strengths of the three studies reported in this dissertation with respect to the four criteria are described in Table 5.1.

Table 5.1 Research trustworthiness, strengths and limitations (Shenton, 2004)

	1. Place-based classification	2. Informal institutions and adaptation	3. Images as information
Credibility: How congruent are findings with reality?	- Methodology consistent with established methods (directed content analysis) - Member checking - Reflexivity - Multiple sources for code definitions (triangulation)	- Methodology consistent with established methods (directed content analysis) - Member checking - Reflexivity - Multiple sources for code definitions (triangulation)	- Mixed method approach (survey and follow-up interviews) - Audience study consistent with established methods - Member checking - Reflexivity - Iterative process with follow-up interviews conducted - Artwork outside of Western worldview
Transferability: Having a systematic plan that can lead to study replication	- Detailed information provided about the research context, participants, data collection, and methods employed	- Detailed information provided about the research context, participants, data collection, and methods employed	- Study bounded by the target audience of public sector practitioners and the context of environmental governance - Study findings are not generalizable due to small sample size

	1. Place-based classification	2. Informal institutions and adaptation	3. Images as information
Dependability: Possibility that the work could be repeated in a similar context	- Detailed reporting of materials and methods	- Detailed reporting of materials and methods	- Detailed reporting of materials and methods - Reflection on the effectiveness of proposed research materials
Confirmability: Reducing intrusion of researcher bias	- Two researchers participated in the first round of coding with high intercoder agreement achieved - Only one researcher participated in the second round of coding. Potential for bias mediated by the presence of an audit trail established through detailed description of the study's design and implementation	- Same	- Same

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Appendices

Appendix A

IRB approval/exemption letters

See supplementary materials

Appendix B

Wainwright Traditional Council Resolution

See supplementary materials